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National Chemical Societies.

During the week between Christmas and New Year American chemists and chemical engineers inclined to attend chemists' conventions were kept busy. The American Institute of Chemical Engineers held its first annual meeting on Dec. 28 and 29 in Pittsburgh. The American Chemical Society began immediately afterward, in Baltimore, its thirty-ninth general meeting, which lasted to Jan. 1. Both meetings—accounts of which will be found elsewhere in this issue—were decidedly successful. The Baltimore meeting was exceedingly well attended. Not much less than 500 chemists were present, and there was much rejoicing in the new spirit of activity manifest in the American Chemical Society. The society has grown rapidly during the last years, but developments in various directions clearly indicated the necessity to do something out of the old ordinary ways in order to hold together successfully the membership steadily growing in number and heterogeneity. Hence the new policy of decentralization with the formation of special sections, like that of industrial chemistry, with its own well-edited journal. Any special brand of chemists may now find a certain limited degree of recognition and furtherance within the American Chemical Society under its new benevolent paternal policy. It is not fair to deride this new policy as a lucky afterthought and the new spirit of progressive activity as forced upon the society by outside developments ("Du glaubst zu schieben und du wirst geschoben"). Even though there is some truth in this, the new spirit must be recognized to exist, and the congratulations which were showered by the membership at large on the members of the council of the society at the Baltimore meeting were well deserved.

* * *

The Pittsburgh meeting of the American Institute of Chemical Engineers was awaited with considerable interest, since it was the first general meeting of the Institute and the record made at this meeting would have a decided influence on its future development. As we said already, the meeting was a full success. Naturally, with respect to attendance, this meeting could not stand any comparison with the Baltimore meeting of the American Chemical Society. But such a comparison would be wholly unfair. The Institute of Chemical Engineers is planned to be not so much a society open to all interested in its field, but rather something like a national club, restricted in membership and comprising men of the same professional type. Dr. Sadtler's presidential address made out a very good case for the formation of the Institute, and the excellent program of papers proved conclusively that chemical engineering is broad and diversified enough to combine in a common organization men of varied interests but with a common broad engineering viewpoint, and to offer something new and interesting to all of them. The broad viewpoint was the characteristic signature of the meeting as a whole and of the different papers. It must be emphasized again and again that chemical

engineering is broader than industrial chemistry, since the chemical engineer enters with his way of thinking and looking at things into every field of engineering activity, and his work is by no means restricted to the chemical industries. That there may be even a clash between the views of the chemical engineer and of the industrial chemist, was clearly borne out by Dr. Brewster's interesting paper on the sanitary condition of the southern end of Lake Michigan, since the chemists of the glucose factory in question, if they are nothing more than industrial chemists, will hardly like the conclusions of the author who spoke as a chemical engineer.

* * *

The whole first session was devoted to the various problems which the chemical engineer has to solve in a boiler plant. Dr. Gudeman took an excellent common-sense view of what the boiler-plant proprietor wants and needs when he has his coal tested by a chemist. Mr. Booth discussed the possibilities of reducing the different losses in a steam power plant. Mr. Greth dealt with the related subjects of scale formation and corrosion in boilers. Dr. Hunicke used the results of the boiler tests of the U. S. Geological Survey to discuss a very interesting problem—namely, to determine the complete history of a combustion process from the analysis of the fuel and of the flue gases. While the result of Dr. Hunicke's investigation is chiefly negative, it should have a profound positive effect on engineers making such boiler tests in future. Flue gas analysis is a very useful method which can often give valuable information on the way in which a process is carried out; and it is a method to which still insufficient attention is paid in many cases. For instance, in all experiments on the reduction of iron ores in the electric furnace it is of great importance that such gas analyses should be made.

* * *

Mr. Meade in his paper on the use of pulverized fuel for industrial purposes took up a subject that should interest many chemical and metallurgical engineers. The possibilities of the different methods of firing furnaces are not yet as fully understood as they could and should be. It is a remarkable fact that producer gas for firing industrial furnaces is much less used in this country than abroad. The knowledge of the possibilities of pulverized fuel is even still more restricted; while it is predominant in the Portland cement industry, it is practically unknown outside of this industry. From Mr. Meade's paper it would appear that this is a subject that should be carefully considered by metallurgists. While pyrometers were known chiefly to scientific men only a few years ago, we have witnessed during the last years a decided pyrometer boom in many industries and there are all indications that this boom is going to last. We have also had many papers on pyrometers, chiefly descriptive of the different principles and constructions. Dr. Northrup's paper was a welcome exception from the rule, dealing broadly and most instructively with electric resistance pyrometry from the viewpoint of the user. Low-temperature work was touched incidentally at the meeting by the paper of Dr. Frerichs on liquid ammonia. Mr. Thorn Smith's paper covered an interesting controversial point of the theory of the contact process of making sulphuric acid. Finally, Dr. Grosvenor's paper on dryer design was an excellent proof of the rule that the chemical engineer must base his calculations and designs on a broader foundation than pure chemistry. Chemical engineering must be applied physical chemistry. These were the papers actually presented at the meeting, the balance being read by title. This indicates a lack of time, as is the common experience of all societies. The American Institute of Chemical Engineers may find it advantageous to have its papers printed and distributed to its members in advance. With its restricted membership this would not be impracticable, and since the papers are to be printed anyway, the cost would not be prohibitive. This practice would save valuable time in the presentation of papers, but, above all, it is the best and only method to get out a good discussion.

* * *

In addition to the American Chemical Society and the American Institute of Chemical Engineers, there is the American Electrochemical Society, now seven years old and rapidly growing in membership and prestige. In all we have, therefore, now three national chemical societies in this country. But the field is so broad that there is open for each of them a career of usefulness and activity, with glory enough for all. Though independent, they all could and should coöperate in a fine liberal spirit to promote the common interests of chemistry, each in its own sphere of influence. It is high time that narrow jealousy should cease. It should no longer be possible or practicable for a distinguished industrial chemist to rise in an important committee meeting with the complaint that electrochemical engineers and inventors get all the public recognition and the "poor pure chemists" get nothing. Those overzealous members of the American Chemical Society who even now, again and again, bring forward the suggestion of absorbing the Electrochemical Society, should finally learn that such a scheme is, to put it mildly, an anachronism. And the formation of the American Institute of Chemical Engineers should also be taken as an accomplished fact; the American Chemical Society can find no better friends than among the founders of the Institute. It is all very well to speak of the tendency of the times to form commercial combinations and trusts for manufacturing on a large scale. But science, pure and applied, is promoted not in such a way. What counts here is individuality, the man as man. Great advances are made by opposing individualities. For the promotion of science and engineering, even in a limited field like chemistry only, nothing could be worse than the combination of the various scientific and engineering societies into one unit, with one publication committee and an editor in charge who as a practical dictator would determine what is suitable for publication and what not. It is unnecessary to add another word.

Detinning of Tin Scrap.

The rapid growth of the tin plate industry has brought with it the problem of detinning the tin scrap left useless in tin can factories; an even more important commercial problem is the detinning of the old used tin cans. From an engineering standpoint the former problem is immensely easier than the latter. The tin scrap of the factories is a pure starting material, consisting of nothing but steel and tin, while the used tin cans contain all kinds of impurities, so that in this case a complicated preliminary purification is required. The paper of Dr. Karl Goldschmidt, found elsewhere in this issue, gives a clear and concise sketch of the history of the detinning industry.

The author is pre-eminently fitted to write this sketch, since he and his brother, Dr. Hans Goldschmidt, of thermit fame, founded the detinning industry, first developing the electrolytic detinning process and during the last years chlorine detinning. The products of the former are steel and tin; in the average it may be said that the value of the detinned steel sold to open-hearth plants is about as much as the value of the tin recovered. The products of the chlorine detinning process are steel and tin tetrachloride; the latter has a ready market in silk mills. It is interesting to note that the chlorine detinning process has proven commercially so much superior to the old electrolytic process that after successful working of the latter for many years at the Goldschmidt works in Essen (treating yearly 50,000 tons), it has now been completely supplanted by the chlorine process; for a time both processes had been used side by side at these works, to compare them carefully.

* * *

While the electrolytic detinning process thus appears to be doomed, another electrolytic process will gain by this change. This is the production of caustic soda and chlorine by electrolysis of common salt. From a commercial point of view, the caustic soda had always been the better half of the process, as it finds an easy market with reasonable prices. The utilization of the chlorine, on the other hand, has met with difficulties, and some manufacturers would have preferred to let it pass off into the atmosphere had that been possible without damage suits. The chief product made from chlorine has always been bleaching power. But while the amounts of caustic soda and bleaching powder produced in this way are chemically equivalent, the commercial demand for both products does not agree with this chemical equivalence. The obvious result was overproduction of bleaching powder and low prices. Hence the continuous endeavor of the producers of chlorine to find new uses for it. One successful outcome of these endeavors is the chlorine detinning process, and it is significant that for its development the possibility of liquefying chlorine cheaply was of importance. It is very probable that when liquid chlorine becomes commercially available in this country, other advantageous applications of chlorine may be developed.

The United States Geological Survey.

The report of the United States Geological Survey for 1908 shows in an interesting way the growth of the scope of its work in recent years. Beginning in 1879 with an appropriation of $100,000 for the classification of the public lands and the examination of the geological structure, mineral resources and products of the public domain, the duties imposed by Congress on the Survey have steadily grown, until its field of operation covers now the whole country, including Alaska. Simultaneously, the appropriations have grown; in 1908 they amounted to $1,782,770. The name "geological survey" really no longer fits the work, as it is no longer restricted to the science of geology and the study of ore deposits. Other matters, like mine explosions and rescue work, the prevention of waste, the testing of building materials, etc., now form an important part of the Survey's work and publications. As to the primary work of the Survey—the preparation of a geologic map of the United States—the report states that geologists have been at work during the year in many of the Eastern States, from Maryland to Texas, investigating the distribution of the rock formation and correlating the underground water-bearing beds. During the last field season 26,994 sq. miles of topographic mapping were completed. Extensive work has also been done in the oil fields, and it has become evident that one of the greatest needs of the petroleum industry is a general chemical examination, by uniform methods, of all the crude petroleums of the United States.

* * *

Those new investigations mentioned above as being beyond the original scope of the work of the Survey were mainly carried out by its Technologic Branch. A notable event was the opening of the Pittsburgh experiment station for the purpose of investigating the causes of mine disasters. One of the results obtained there is the proof that coal dust is as dangerous an explosive as firedamp. It is proposed by the Survey to standardize commercial explosives so as to get a definite idea of what each charge of powder will do. A special and somewhat spectacular feature of this experiment station is a gas-filled room in which miners equipped with oxygen helmets are being trained in rescue work. At the structural materials laboratories at St. Louis the tests of the strength of the different materials of construction and of the fire-resisting qualities of these materials were continued. At Pittsburgh a laboratory has been established for investigating the chemical and physical properties of clays and clay products. Finally, the work at the different fuel-testing plants must be noticed. At Pittsburgh successful experiments with very poor coals have been made, while at Denver it has been shown that practically all the coals of the Rocky Mountain fields yield coke suitable for metallurgical purposes. The work of the fuel-testing plants is very important. Dr. Hunicke, in his paper before the American Institute of Chemical Engineers, printed elsewhere in this issue, offers some important criticisms of the flue-gas analyses made in this work of the Survey. It seems desirable that the Survey give more attention to the chemistry of the problems investigated. Perhaps the general criticism is justified that these newer technological investigations of the Survey are not yet up to the mark in every respect from a scientific standpoint. But this is no good reason to condemn the extension of the scope of the work of the Survey.

Sampling and Analysis of Iron Ores.

In this issue we print the complete official account of the methods of the United States Steel Corporation for the commercial sampling and analysis of iron ores. This report was prepared by a specially appointed Chemists' Committee, with Mr. J. M. Camp, chief chemist of the Duquesne works of the Carnegie Steel Company, as chairman. The preparation and publication of this report is the outcome of the natural desire of the U. S. Steel Corporation to standardize their methods of sampling and analysis. The question arose how far to go in standardization. In the description of the methods of analysis the idea of the Committee was evidently to outline, in a general way, the procedure without too close attention to the details, leaving these to the chemists themselves. This was probably a wise policy. The report should attract careful attention, both for the eminence of the source from which it emanates and for the great care which has evidently been taken in its preparation.

Baltimore Meeting of the American Chemical Society.

The meeting of the American Chemical Society, held simultaneously with the American Association for the Advancement of Science in Baltimore from Dec. 29 to Jan. 1, was more largely attended than any previous meeting of the society, and was unusually enthusiastic.

The local committee had made special arrangements for the entertainment of the visiting chemists, consisting of banquet and smoker, automobile rides, parties and dinners for the attending ladies, and excursions to Annapolis, to the Maryland Steel Company's works, to the various Baltimore breweries, to Sharp & Dohme's works and to various points of interest around the city.

Some 425 chemists were present and attended the various sectional meetings of the society, besides addresses given in general session.

These general addresses have proved a very attractive feature of recent meetings. Those delivered at Baltimore were:

The Untilled Field of Chemistry, A. D. Little.

The Use and Abuse of the Ionic Theory, Gilbert N. Lewis.

The Work of Werner on the Constitution of Inorganic Compounds, Charles H. Herty.

The Future of Agricultural Chemistry, H. J. Wheeler.

The Quantitative Study of Organic Reactions, S. F. Acree.

The Classification of Carbon Compounds, Edward Kremers.

The Efficiency and Deficiencies of the College-Trained Chemist when Tested in the Technical Field, William H. Nichols.

To What Extent Should College Training Confer Practical Efficiency Along Technical Lines? Louis M. Donnie.

The Attitude of Technical Institutions to Post-Graduate Study, William McMurtrie.

To these should be added the addresses of President M. T. Bogert, of the American Chemical Society on "The Function of Chemistry in the Conservation of Our Natural Resources," and of H. P. Talbot, vice-president of Section C of the American Association for the Advancement of Science on "Science Teaching as a Career."

Over 160 papers were announced and read before the nine different sections into which the meeting was divided. The recently organized Division of Industrial Chemists and Chemical Engineers was in session on four separate days. Notable papers presented before this section were by E. G. Bailey on "Accuracy in Sampling Coal," and by W. H. Walker on a new method of quickly finding imperfectly covered spots on tin plate.

The following divisions were officially authorized and have organized and elected officers: Division of Physical and Inorganic Chemistry; Division of Agricultural and Food Chemistry; Division of Organic Chemistry; Division of Fertilizer Chemistry.

The Iron and Steel Market.

January has not fulfilled expectations in the iron and steel trade. A continuance of the progressive improvement which characterized the second half of last year was expected, and the more sanguine were disposed to look for an increase in the rate of improvement. The outcome has been in the contrary direction. Most producers have found materially less business in January than they did in December, and in many branches of the trade the market has been extremely dull.

On the whole, the railroads are probably buying as liberally as they did in the closing months of 1908, but there is that about the character of their buying which does not promise much increase in this half year at least. In rails, for instance, the orders, as a rule, are for small tonnages and for early delivery. Such orders indicate that, as was expected, some railroads have got to a point where they cannot longer defer replacement of worn-out rails, but it was not expected that when railroads should reach this point they would buy in such small quantities. Some steel car orders are being placed, which make a not altogether insignificant tonnage, but it is patent that it is only an occasional road, particularly well fixed financially, or particularly short of rolling stock which is buying. That the rail tonnage is quite insufficient to the capacity may be illustrated by a couple of instances. The Pennsylvania system did not place any regular order for 1908 on account of the dispute as to specifications, so that its order for 1909 should have been particularly large. It amounted, however, only to 135,500 tons, less than the average for several years preceding 1908. The Edgar Thomson mill is working on its allotment of the Pennsylvania order, deliveries to be completed by May or June, and yet is running only to 35 per cent or less of its capacity. The Chicago rail interest, which must also take care of the new Gary plant if it runs, has been booking only a few thousand tons a week, although having a capacity of 40,000 or 50,000 tons a week to take care of.

In the lighter lines, which showed such a steady run of business last year, most of the accounts are unsatisfactory. The wire trade has been doing best of all, and is running at between 60 and 75 per cent of capacity. Pipe has been quiet, and sheets have not been doing as well as toward the close of last year. Tin plate has been quiet, but the mills entered the year with a good volume of business on books, and are more than holding their own as to operations. In bars specifications have decreased somewhat and new business is extremely light.

PIG IRON.

The month has been the dullest in pig iron for a long period. There has been a fair measure of activity in low-grade iron, particularly Southern, for pipe works. Foundry iron has been extremely dull in all markets. Bessemer in the Central West has been dull, and has shown a decided weakness in price besides. A few good transactions in basic have been made in the East, while in the Central West nothing of importance has been done since the Pittsburgh Steel Company's purchases, amounting to about 20,000 tons, for first quarter, were made late in December. Prices on the whole have been well maintained, but the market has not been seriously tested and it is not altogether certain that they can be maintained through a continuation of this dullness. The temper of the trade is evidently that there is more prospect of a recession than of an advance. The annual question of Lake Superior ore prices is about to engage the attention of the trade, and the question comes up under rather unfavorable auspices this year, on account of the naming of 1907 prices in February of last year and the subsequent 50-cent reduction in June. Previous to that experience the merchant ore interests had maintained the reputation of adhering to prices, once announced, through the season. Last year they were led by extraneous influences into a premature announcement.

December pig iron production showed a heavy gain over November, and the rate of production on Jan. 1 was still higher, being close to 21,000,000 tons a year. January production may equal that of December, but there seems to be no dissent in any quarter from the generally expressed view that the slackness in new business in January must force a lower rate of production within a short time. Already there has been a material increase in stocks at furnaces, and in some isolated instances nearly the entire January output has gone into stock piles.

There has been no distinct change in quotable prices except that in all districts there has been a withdrawal from the position of asking a 25- to 50-cent advance for second quarter delivery over first quarter. In all districts there are furnaces ready to do first-quarter prices for second-quarter delivery, while first-quarter prices are not quotably changed. Bessemer iron is nominally unchanged at $16.50, valley, but is very weak at this price. Otherwise prices quoted are understood to be well maintained, although the market is not being seriously tested. We quote as follows: Philadelphia, $17.25 to $17.50 for No. 2 X foundry; f.o.b. valley furnace, No. 2 foundry, $15.50; basic,

$15.50; Bessemer, $16.50; forge, $14.25; Chicago No. 2 foundry, $17 at furnace, or $17.35 delivered, meeting delivered prices on Southern iron; the South, $13, Birmingham, for No. 2 foundry.

BILLETS AND SHEET BARS.

In the East there is more disposition to shade the regular delivered prices, there being several producers open to negotiation on desirable tonnages, but very little business has come up In the Central West regular prices are understood to be maintained, these remaining on the basis of $25 for billets and $27.50 for sheet bars, Pittsburgh.

FINISHED MATERIALS.

While shading in one finished steel product or another was not absent at any time last year, there is probably more shading now than at any previous time. Shapes, plates and sheets are being shaded more or less, perhaps only by $1 or $2 a ton in the case of sheets, but by more than this in the case of shapes for important structural contracts. Light rails are easier, selling at $22 to $23, the official price being $25. Official prices remain as follows, being f.o.b. Pittsburgh, with the exception of rails, which are f.o.b. mill:

Standard rails, $28 for Bessemer; $30 for open-hearth.

Plates, 1.60 cents for tank quality.

Shapes, 1.60 cents for beams and channels, 15 in. and under, angles and tees.

Steel bars, 1.40 cents; iron bars, 1.50 cents, delivered Pittsburgh or Chicago.

Plain wire, 1.80 cents; wire nails, $1.95.

Sheets, 2.45 cents, net, for black; 3.50 cents, net, for galvanized, 28 gage.

Tin plates, $3.65, net, for 100-lb. cokes.

An Alleged Patent Fraud.

On Jan. 12 the grand jury at Lockport (the county seat of Niagara County, New York) found four indictments against Mr. Charles E. Acker, of the late Acker Process Company, of Niagara Falls, one of the indictments being for perjury, the other three for subornation of perjury.

The case is the outcome of a patent interference case on a process of detinning by means of chlorine, between Dr. Karl Goldschmidt and Dr. Joseph Weber, of Essen, Germany, on one side, and Mr. Charles E. Acker on the other side.

The two patents of Goldschmidt and Weber of importance in the case are No. 822,115 of May 29, 1906, and No. 831,223 of Sept. 18, 1906. Full abstracts of these patents were given on pages 328 and 419 of our Vol. IV (1906), while a statement concerning the formation of the Goldschmidt Detinning Co., which will operate under these patents in this country, will be found, together with a review by Dr. Karl Goldschmidt of the whole detinning industry on page 79 of this issue.

In view of the publicity which the perjury charge has found in the public press, we give below concise statements of all parties.

* * *

According to the indictments, the alleged perjury was committed by Mr. Acker in swearing that he reduced the invention of the Goldschmidt patent 831,223 to practice in the early part of December, 1902; the alleged subornation of perjury was committed by inducing three men to testify that they had helped Mr. Acker in these experiments, while, it is alleged, these experiments were not made at all.

* * *

According to a statement given to the press by Mr. Hubert E. Rogers, of counsel for Drs. Goldschmidt and Weber, the situation is as follows: To Goldschmidt and Weber a patent was granted (No. 822,115) on May 29, 1906, on a process for removing tin by means of chlorine gas from tin scraps, and a further patent, on Sept. 8, 1906 (No. 831,223), on a modification of the same process. It is alleged that within three weeks after the issue of the first patent Acker filed an application in the patent office covering the same subject as that of the patent, that within three weeks after the issue of the second patent he filed an amendment to this application which contained, word for word, as well as the punctuation, 14 of the 16 claims of the latter, and then applied for interference proceedings.

Under the United States patent laws a foreigner is limited in date of invention to the date on which a corresponding patent in his own country was published, while a domestic inventor can prove the date of his invention by testimony. Goldschmidt and Weber's date was March, 1905.

In the interference proceedings Acker stated that early in December, 1902, he first made use of his idea by a practical demonstration of it in the laundry tubs in the laundry of his house in Niagara; that he continued his experiments on an average of at least once a week at the same place until Christmas of 1902, and thereafter in the basement of the works of the Acker Process Company, at Niagara Falls, until April or May, 1903, after which the apparatus was returned to the cellar of his home, where he worked on the invention at least once a week until February, 1906.

Four witnesses were called to support this statement, all former employees of the Acker Process Works.

The lawyers of Goldschmidt and Weber state that in investigating this testimony they located practically all of the servants who had been employed by Acker at his residence during the period covered by the operations described by him, and that none of them knew anything of any detinning or chemical operations having been conducted in the laundry. It is alleged that attempts were then made by Acker to influence these witnesses in giving testimony, and complaint was made to the district attorney of Niagara County. It is alleged that after having heard the stories of these witnesses, the district attorney sent for the three young men who had given testimony to the effect that they had assisted Acker in the operations in the laundry, and questioned them, and that as a result each of them broke down and confessed that his story was false from beginning to end, whereupon application was made to the Patent Office at Washington to have the case (which had then been closed) reopened, and the Patent Office granted this request, reopened the matter, and these three witnesses were again put on the stand and testified that their testimony formerly given was false throughout.

It is stated that thereafter the interference case came on for hearing before the Patent Office authorities, and judgment was rendered in favor of Goldschmidt and Weber against Charles E. Acker on Oct. 13, 1908. Limit of appeal having elapsed, a further and final judgment was rendered in the interference case against Charles E. Acker on Nov. 2, 1908.

* * *

Mr. Charles E. Acker makes the following statement:

"This prosecution grows out of a litigation concerning certain patents or applications owned by the Tin Products Co., of New York, relating to a process of detinning, the parties to which were Goldschmidt and Weber, of Germany, upon the one side, and myself on the other.

"The witnesses whom it is claimed I induced to testify falsely in that litigation were examined at great length and in the minutest detail in a public hearing in which both parties were represented by attorneys, Mr. Dane, of New York, representing Goldschmidt and Weber, and Dr. Byrnes, of Washington, representing myself, and some time after their testimony had been given they were induced, by some means, to go, again, upon the stand and testify that they had sworn falsely in some particulars and had been induced to do so by me.

"It developed that the attorneys for Goldschmidt and Weber had pressed the district attorney of Niagara County into their service and that he had required the presence of these witnesses at his office and obtained from them statements to the effect that their testimony was false, and had then immediately turned over these affidavits to the attorneys for Goldschmidt and Weber for use in the litigation. This occurred about seven months ago. Many grand juries have convened in Niagara County during

these seven months and these charges have not been presented by the district attorney until now. The fact that the district attorney first procured these witnesses to say that they falsely testified; that he turned over their statements to the attorneys for Goldschmidt and Weber for use in the litigation; that he has permitted seven months to elapse without making any move toward a judicial investigation of the charge against me, and that he now acts only upon the request of the attorneys for Goldschmidt and Weber, and that he refused to permit my side of the case to be heard before the grand jury are circumstances which seem to call for an explanation and characterizes this prosecution as an effort to advance the interests of one of the parties to a civil litigation rather than as a performance of a public duty.

"I can only say that I am guiltless of the charge made against me, and I feel sure that when I am accorded a fair hearing that I will be vindicated."

Pure Food Law.

While going to press it is reported from Washington that the "unofficial" referee board of chemists appointed by President Roosevelt has decided that benzoate of soda used in food as a preservative is not harmful and deleterious to human health. In this position the board flatly joins issue with Dr. Harvey W. Wiley, Chief of the Bureau of Chemistry of the Department of Agriculture, who held that benzoate of soda is harmful.

The referee board was appointed last March and consists of Dr. Ira Remsen, of Johns Hopkins University; Russell H. Chittenden, of the Sheffield Scientific School of Yale; John H. Long, of the medical school of Northwestern University; C. A. Herter, of the College of Physicians and Surgeons, Columbia University, New York, and Alonzo E. Taylor, of the University of California. Dr. Taylor has been absent in Europe and has not participated in the consideration of the question. Otherwise the report of the board is unanimous.

The referee board reached its conclusion after experimenting on a "poison squad." Dr. Wiley also reached his conclusion after experimenting on a "poison squad." In presenting the issue the President submitted to the board two propositions, as follows:

1. Does food to which there has been added benzoic acid or any of its salts contain an added poisonous or other added deleterious ingredient which may render the said food injurious to health? In large quantities? In small quantities?

2. If benzoic acid or any of its salts be mixed or packed with a food, is the quality or strength of said food reduced, lowered or injuriously affected? In large quantities? In small quantities?

The main general conclusions reached by the board are:

First—Sodium benzoate in small doses (under 0.5 gram per day) mixed with the food is not deleterious or poisonous, and is not injurious to health.

Second—Sodium benzoate in large doses (up to 4 grams per day) mixed with the food has not been found to exert any deleterious effect on the health nor to act as a poison in the general acceptation of the term. In some directions there were slight modifications in certain physiological processes, the excess signification of which modifications is not known.

Third—The admixture of sodium benzoate with food in small or large doses has not been found to injuriously affect or impair the quality or nutritive value of such food.

CORRESPONDENCE.

Heat Conductance Through Furnace Walls.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—Your January issue, page 8, contains a reference to my recent paper by an engineer in Denver. I appreciate his complimentary remarks, but I think he has misunderstood me in some of his statements.

The paper states clearly that it refers only to one part of this calculation and not to a determination of the conductivity constants. The latter are supposed to be looked up in tables. The result, of course, will be no more accurate than these constants are; but, on the other hand, if made as I described, these calculations will not increase the inaccuracy as they did in the former and more usual methods. It was hoped that a greater possible accuracy in this one part of the calculation would lead to more accurate redeterminations of these conductivity constants; in fact, one object of my paper was to stimulate the interest in such redeterminations. Moreover, the results of my deductions have pointed out a new and simple method of determining these constants with much greater accuracy than heretofore.

Your correspondent is in error when he virtually says that these calculations are of little use for predetermining the loss in a new furnace, until these constants have been redetermined. Many of these constants are contained in tables, and many have been published in this journal. These can well be used and, in fact, have been used by myself and doubtless by many others for new and old types of furnaces. The fact that they are less accurate than the calculations which I described, is no good reason why they should not be used, nor why my determinations are not practicable.

Philadelphia, Pa. Carl Hering.

Proposed Court of Patent Appeals.

To the Editor of Electrochemical and Metallurgical Industry:

Sir:—It might interest your readers to know that before the sixtieth Congress, first session, a bill has been introduced in the House of Representatives by Mr. Currier, the number of which is H. R. 21,455. Copies can be obtained from United States government by applying to their representatives. This bill is called "A Bill to Establish United States Court of Patent Appeals and for Other Purposes."

If this bill is passed it will do away with the grievous conditions that exist now in patent decisions before the Circuit Courts. The bill has been favorably reported upon, as will be seen by reading the arguments before the Committee on Patents of the House of Representatives, March 18, 1908, number H. R. 14,047.

All chemists, all enginers, all inventors, as well as the public at large, are interested in this subject and it is very desirable that this bill should pass.

Those who are willing to aid in this work are requested to write letters to the House and Senate favoring its passage. Write first in order of preference to members of the House Judiciary Committee and then to the members of the Senate Committee on Patents.

Yonkers, N. Y. L. H. Baekeland.

[The Senate Committee on Patents consists of Senators Reed Smoot, of Utah; William H. Milton, of Florida; Frank B. Brandegee, of Connecticut; Alfred B. Kittridge, of South Dakota; Murphy J. Foster, of Louisiana; Moses E. Clapp, of Minnesota, and Frank B. Gary, of South Carolina. The Committee on Judiciary of the House of Representatives consists of Representative John J. Jenkins, of Wisconsin, chairman; DeAlva S. Alexander, of New York; Charles Q. Tirrell, of Massachusetts; John H. Foster, of Indiana; Ruben O. Moon, of Pennsylvania; George R. Malby, of New York; David A. De Armond, of Missouri; Robert L. Henry, of Texas; Charles C. Reid, of Arkansas; Richard Wayne Parker, of New Jersey; Charles E. Littlefield, of Maine; John A. Sterling, of Illinois; Henry T. Bannon, of Ohio; Garrit J. Dickman, of Michigan; Henry S. Caulfield, of Missouri; Henry D. Clayton, of Alabama; William G. Brantly, of Georgia, and Edwin T. Webb, of North Carolina.]

Pittsburgh Meeting of the American Institute of Chemical Engineers

The first annual meeting of the American Institute of Chemical Engineers was held in Pittsburgh, Pa., on Dec. 28 and 29.

All the sessions devoted to the reading and discussion of papers were held in the lecture hall of the Carnegie Technical Schools. Simultaneously an exhibition of various chemical engineering apparatus and machinery was held in the basement of the same building. A complete account of this exhibition will be found on pages 89 to 92 of this issue.

Professional sessions were held on Monday morning and evening and on Tuesday morning and evening. The afternoons had been reserved for excursions to the Duquesne plant of the Carnegie Steel Company, to the works of the Westinghouse Machine Company and to the U. S. Government Explosives Testing Laboratory in Pittsburgh. On Dec. 30, after the official close of the meeting, various members made an excursion to the by-product coke works of the Carnegie Steel Company, at South Sharon, Pa.

The Institute has at present 88 members. All the officers which had been elected at the organization meeting at Philadelphia last June were re-elected (see our Vol. VI, page 272).

Since we comment on our editorial pages on the undeniable success of this first general meeting of the Institute, this report will go at once in medias res. In the following we give abstracts of the papers presented; the papers will be printed in full in the *Proceedings* of the Institute.

* * *

The first session on the morning of Dec. 28 was opened by a speech of welcome from the Carnegie Technical Schools, to which the president of the Institute, Dr. Sam. P. Sadtler, replied. He referred to Pittsburgh as a pre-eminent center of chemical activity and to the Carnegie Technical Schools as a typical example of the kind of schools we wish to see developed.

During the morning session papers were read by Messrs. Gudeman, Booth, Greth, and Hunicke.

Technical Coal Analysis.

The first paper was presented by Dr. EDWARD GUDEMAN, of Chicago, on technical coal analysis, especially for such works where the maximum daily consumption does not exceed 50 tons of coal per day. This includes at least two-thirds of all stationary steam-boiler plants in the United States.

The operating forces of such plants are not of exceptional skill, and about all the information one can get in such plants is the cost of coal per ton and what they believe has been their daily or annual consumption. The cost figures are generally correct, but the amount used may be within 10 per cent of correct, as in very few cases the coal is weighed in, in fact, even at plants with a daily consumption of up to 500 tons, Dr. Gudeman has seen the capacity of cars taken as the amount of actual delivery.

What is now the purpose of technical coal analysis for such plants? According to Dr. Gudeman, the object of any technical analysis is two-fold: First, to judge the product itself, and, secondly, to give to the consumer information as to the value of the product. This valuation can be directly in dollars and cents, compared with a standard product used for same or similar purposes, or in terms of efficiency for actual usage.

Applying these objects to the technical analysis of coal, used for steam production, valuation should be as to what the coal is worth in dollars and cents based on its efficiency, under the specific conditions in which it is used, that is, the report of analysis should give its evaporation power and figure the cost of the steam made per unit of coal used.

Dr. Gudeman thinks that technical coal analysis, as now generally carried out, comprises too many unsuitable determinations, while the results are given in a few detailed figures, which the manufacturer, for whom the report is made, does not understand. The thermal units are made the whole show and the value in the coals is given in B.t.u's., generally with heavy type, but using the initials only, as that makes it look more mysterious.

Our present-day determinations consist of the determination of water, occluded gases (air) and direct determination of hydrogen, nitrogen, oxygen, possibly carbonic oxide and acid, also the sulphur, phosphorus, iron, silica, lime and sometimes mineral matter, and sometimes ash.

The thermal heat units are determined one way or the other, preference being given to this or that piece of apparatus, based mainly on the experience of the analyst with his favorite apparatus. If he gets good duplicate results, he is satisfied and swears by that apparatus. If his results do not duplicate, due to inexperience, carelessness or ignorance, the apparatus is at fault and "n. g." The author has heard one very good instrument very severely criticized because it gave abnormal results if glass was ground in with the coal.

In present reports the value of the coal is mainly based on thermal units and these are reported, first, for the coal as delivered, then for the cool air dried, then for the coal kiln dried (drying in bath), then the same calculations are made for coal ash-free, ash-and-sulphur-free, ash-and-sulphur-and-gas-free, and so on.

Dr. Gudeman continued pertinently: "This is a sort of house that Jack built, and I expect before long some one will make correction for argon and another will take radium or other emanations into consideration, while others will apply the ionic theory or make correction for dissociation due to something or other."

What the consumer wants, and should get, is what the coal is worth, and he should get this in the simplest and most concise form, in such a form that he can interpretate the results and compare the different reports and value his coal.

The reqiurements for quantitative coal analysis during Dr. Gudeman's student days were to determine water, volatile and fixed carbons, ash and sulphur. And it is a fact that these determinations are sufficient for all practical purposes to value and grade coals, and that the b.t.us. calculated therefore are as close as and generally much closer than the direct calorific tests when applied to actual results obtained in burning the coal under the boilers. For this calculation of thermal units Dr. Gudeman uses an empirical figure of 13,500 B.t.u's. for fixed carbon and 16,500 for volatile carbon.

He determines the water in coal, or what he calls water, by drying in the hot-air bath for one hour at 105° C. He uses a platinum crucible and 2 grams of substance. For very wet coal he dries first on the water bath for one-half hour. After the water is obtained by loss, the crucible is heated 2½ minutes over direct Bunsen burner and then 2½ minutes with blast. This loss is the volatile carbon. The fixed carbon is then burnt off by direct flame over Bunsen burner, and the residue is the ash. Sulphur determination is made on a separate sample using the mixed carbonate and nitrate fusion, taking at least 15 grams of fusion mixture, 2 of carbonate to 1 of nitrate to every 1 gram of coal.

If the B.t.u's. are determined direct and calculated to the water-, ash-, sulphur- and gas-free coal, what are they calculated to? Why all that is left is the volatile matter (volatile carbon) and the fixed carbon (coke). All errors are thereby thrown on the errors of determination of the other constituents. Now if the B.t.u's. are directly calculated on the volatile carbon and fixed carbon found, the only correction required is for the sulphur volatilized with the volatile carbon, which for all practical purposes will amount to one-half of the total sulphur found, and this correction can in most cases even be ignored.

The reporting of the volatile carbon (volatile matter, not water) and fixed carbon, enables the consumer to judge the

coal as to its being hard, soft or medium, and indicates its firing possibilities and its coking properties, none of which are indicated even from the determination of total volatile matter or direct B.t.u's.

Given the grate surface and size, dimension of combustion chamber, and chimney and draft pressure, and size of coal, and amount of volatile carbon and fixed carbon one can quickly give an opinion as to whether the full efficiency is obtained and what the amount and kind of smoke will be.

In the discussion which followed, Dr. Sadtler and Dr. Hart spoke on some details of coal analysis. Dr. Hart called attention to the fact that when iron sulphide is present, both the sulphur and the iron yield heat, but the iron is often lost sight of. When the point was raised that besides the analysis of coal, the method of sampling was of greatest importance, Dr. Gudeman replied that the sample should be supplied to the chemist and that both the buyer and the seller should stand by the sample.

* * *

Steam Power Plant Economics.

Mr. Wm. M. Booth, of Syracuse, N. Y., presented a very long paper on "Steam Plant Economies from the Standpoint of the Chemical Engineer." The combustion of coal, the purification of water, and the control of flue gases are specifically chemical problems, while the designs of the boiler, the kind of fire box, and the physical parts of the plant are definite engineering problems. The chemist and the mechanical engineer here meet on common ground.

Mr. Booth first gave the detailed figures of the cost of a hp-year in a 24-hour plant of the best type, delivering 1000 hp to the generator. The figures were based on actual bids of manufacturers for the cost of apparatus with its erection in Syracuse. The figures do not include the electric generator.

In the first arrangement considered (steam engine) the fixed charges per hp-year (including interest, 5 per cent; depreciation, 10 per cent; taxes and insurance) amount to $7.20, the cost of operation (coal at $4 per ton, wages, etc.), $57.99; hence, total cost per hp-year, $65.19. In another arrangement with a gas-engine equipment the cost per hp-year comes out as $33.45.

Mr. Booth then gave figures of the various losses in steam-power plant, with special reference to Mr. Stott's paper read in 1906 before the American Institute of Electrical Engineers and took up the separate sources of loss with suggestions for improvement.

Water.—In selecting the location of a plant due regard should be given to water supply. The best modern practice is to locate where there are two available sources of supply, each entirely independent of the other. This is necessary not only in connection with the power plant, but also as a protection against fire.

The boiler water must usually be filtered to remove suspended mud, sand and detritus. If less than 10 grains of scale-forming ingredients are present, the softening process may be carried on in the boiler; if more (carrying particularly sulphates), a softening system should be provided. The heater does not remove all carbonates. If water is treated in the boiler, predetermined mixtures of alkaline hydrates and carbonates satisfy the conditions. Frequent blowing of sludge is very necessary with such treatment.

Coal.—While it may cost from 40 to 90 cents to raise a ton of steam coal to the surface of the mine, freight rates are such as to make coal cost in St. Louis $1 to $1.30 per ton, in Chicago $1.50 to $2, while Syracuse manufacturers pay $2.70, Watertown, N. Y., $3 and isolated cities in Massachusetts $4 to $5 per ton for very similar bituminous coal.

Coal should be purchased in the same way as iron ore, according to its value—so much per unit, with allowances for high ash and sulphur.

To ascertain grate economy, Mr. Booth made tests in four plants. The results were as follows: In the first 16 per cent combustible material in ash, 1.33 per cent coal not burned; in the second 31.5 per cent combustible material in ash, 4.6 per cent coal not burned; in the third 10 per cent combustibles in ash, 3.51 per cent coal not burned; in the fourth 36 per cent combustibles in ash, 5.6 per cent coal not burned. There is unquestionably an average fuel loss in ash that the power-plant owner might consider with profit.

Flue Gases.—Mr. Booth then discussed at some length the use of apparatus for testing flue gases. The general tendency in firing a boiler is to get a pronounced draft if possible and to drag an enormous quantity of air over the fire. This is air heated without useful results. The best means for determining the efficiency of combustion is by testing the CO_2 content of the flue gases by some CO_2 recorder like the Orsat.

Economizer.—To reduce the stack loss is the second serious problem for the power-plant specialist. Obviously the use of the heat in flue gases must result in large economy. Economizers attempt to recover much of the loss. When, however, water is heated in an economizer at the expense of draft, the very basis of boiler economy is endangered. A fair figure for the cost of a 1000-hp plant economizer would be $5 per horse-power. This equipment is relatively expensive and must result in a large saving if used. If the temperature of the flue gases is reduced from 500 deg. Fahr. to 250 deg. Fahr., saving from 8 per cent to 10 per cent of the coal is useful effort, an economizer ought to be an excellent investment.

Whether the stack will survive is a question. This time-honored and simple method of creating a draft is enormously expensive, approximating 20 per cent of all fuel burned in excellent plants and 50 per cent in poorly-managed plants. The chemist who is said to know no loss would expect to return the exhausted gases to the air at the same temperature as when taken. When this is done the boiler plant can be run much more economically. We are assured that the necessary draft for 1000-hp plant can be furnished mechanically at an expense of 1 per cent of the fuel burned and less if exhaust steam can be used to drive the fan.

Condenser.—"Are all familiar with the enormous loss resulting from the use of steam at low pressure? To condense 1 lb. of steam quickly requires from 14 lb. to 17 lb. of water which is heated without useful results. Thus it occurs that a 4000-hp steam turbine plant is supplied by a 4-in. feed-water pipe while the condensers are supplied with 12 mains. This water has to be heated and carried back to the fire bag with a total loss of the heat contained.

"Could the condenser loss be obviated and this energy be turned to mechanical advantage, the steam-power plant would take a new stand in the mechanical world."

In summing up Mr. Booth said that a highly organized electric plant is capable of delivering 10 per cent of the energy of coal as useful mechanical work. With the latest type of apparatus, including water-tube boilers, superheaters, and steam turbines, the efficiency has been raised to 15 per cent. Surely a remarkable gain over the 6 per cent or 8 per cent of a few years ago or the 3 per cent or 4 per cent of 50 years ago.

Four pounds of coal per hp-hour is good practice, but the steam turbine reduces this coal consumption nearly 50 per cent. With a gas engine and gas producer 1 hp-hour can be produced with 1¼ lb. of coal, producing an efficiency of about 22 per cent to 25 per cent. No steam or gas apparatus can compete with water power with an efficiency of from 87 per cent to 92 per cent of the total energy of the falling water.

Fixed charges are, however, heavy in large installations. A good boiler delivers 70 per cent of the heat of the coal, the average boiler not more than 50 per cent with the enormous condenser loss of the engine. The use of the boiler in chemical plants and wherever steam is required will probably never lessen, nor is this an inefficient apparatus for the purpose intended.

The use of the gas-engine exhaust for practical purposes, especially heating, will do much to bring this form of power into favor. The present cost of the large-unit gas engine and the uncertainty of its operation are opposed to its general use.

Undoubtedly the steam plant will continue for many years on a constantly increased scale as large installations result in the greatest economy.

That the plant may be made the most efficient, expert power-plant engineers must be employed. The plant must be *designed* by the most experienced and *operated* under the guidance of educated men—engineers, firemen and helpers.

The CO_2 recorder and recording pyrometer should be provided in every large plant, the Orsat apparatus should be used in all plants above 250 hp, the coal should be tested, the ash tested as well as the water from the boilers. Firemen should be paid in proportion to their results. Coal and ashes should be handled mechanically. If the plant is built fireproof, the insurance rate may be as low as 25 cents per $100; if not, it may rise to $7.

* * *

Scale and Corrosion of Boilers.

A paper on the chemical aspect of impurities which cause scale and corrosion of steam boilers was read by Mr. J. C. WILLIAM GRETH.

The author gave a systematic discussion of the impurities in boiler waters and their chemical nature, discussing in detail successively their action in forming scale and in producing corrosion. Scale and corrosion are closely connected. But in making general statements on this subject one has to be very cautious. The rate at which a boiler is operated is of great importance. Boilers need the best of water, hence treatment is generally necessary. But purification and softening of boiler water is a very delicate operation.

In view of the great amount of detailed information contained in the paper, it is not possible to give a satisfactory, concise abstract, and the reader must be referred to the full paper to be printed in the *Proceedings* of the Institute.

* * *

Examination of Flue Gases in Boiler Tests.

Dr. H. AUGUST HUNICKE, consulting chemical engineer, of St. Louis, Mo., presented a paper on the examination of flue gases in boiler tests.

If the composition of the fuel and the analysis of the resulting gases of combustion are given, it should be theoretically possible to state the entire history of the combustion process.

With a carbon fuel of simple composition (coke, anthracite coal, etc.) this is a simple chemical problem. But difficulties arise with complex bituminous coal, since this represents really a system of two fuels, one being gaseous hydrocarbons and the other the solid carbon residue, both portions participating at different times to a different extent in the process of combustion.

Dr. Hunicke has endeavored to solve the above problem on the basis of the published government report on the results obtained at the Fuel Testing Plant of the U. S. Geological Survey. But after careful study of the data of the government report he found that the variations of the firing process could not be followed by the individual analysis of the combustion gases made at intervals during each boiler test. However, while a detailed study of each boiler test was not possible, some interesting features were revealed by a study of the averages of the flue gas analysis.

Dr. Hunicke has calculated the results of the flue gas analyses for 78 boiler tests and plotted the results in a very interesting diagram.

The fundamental principle upon which a study of the flue gases is based is the constancy of the ratio of the sum of the volumes of oxygen and carbon dioxide to the volume of nitrogen. As the volume of the oxygen in the air is 21 per cent of the whole, the sum of the volumes of oxygen and carbon dioxide in a flue gas, omitting all interferences for the time being, should be 21 per cent. The term "oxygen equivalent" is used for the sum of volumes of oxygen, carbon dioxide and one-half of carbon monoxide calculated to its equivalent in oxygen as a means of comparison.

Dr. Hunicke's diagram gives curves for the flue-gas composition (in terms of the oxygen equivalent) as it was found experimentally and as it would be theoretically for complete combustion. Three theoretical curves are given; one for complete combustion, without correction for ash, sulphur, etc., except CO; the second curve containing a correction for loss in ash and flue dust and CO; the third also containing a correction for sulphur, assuming that all sulphur burns to sulphur dioxide and is condensed with moisture before carbon dioxide is absorbed by sodium hydrate.

The chief object of Dr. Hunicke's paper is to compare the experimental and theoretical curves and to explain the discrepancies. While a number of the calculated values are very close to the experimental values, there are a number of values which deviate, in some cases very considerably, being either short of the calculated value or in excess of the latter.

All oxygen equivalents smaller than the calculated values seem to indicate that either more or less consumed gas had reached the flues and appears in the analysis as "nitrogen" or else that the samples analyzed were taken mostly during the period of gasification when a greater preponderance of hydrogen would reduce the oxygen equivalent. It is probable that the discrepancy is due to the second cause. It is disappointing to conclude that the number of flue gas analyses made during each boiler test were presumably too few and ill-chosen to permit the use of the results in the sense of representing true averages of the entire test.

The discrepancies were further studied by comparison with the O_2, CO_2 and CO analyses. For this purpose in the upper part of his chart, Dr. Hunicke shows side by side the averages of the carbonic oxide as found by analysis and the deviations of the oxygen equivalents. The diagram shows a parallelism which must be construed to mean that in the case of negative deviations combustion was incomplete, a deduction entirely in accord with the carbonic oxide determinations; while, on the other hand, the positive deviations would indicate that there has been an over-oxidation, a phenomenon not known in connection with the process under consideration.

The question then arises, how to account for oxygen equivalents deviating from the experimental results which are greater than those obtained by calculation? There is again the choice of two interpretations: Either the samples represented predominatingly the period of coke combustion; in other words, an insufficient number of samples were taken during the gasifying periods, or else the fuel analyses, and more particularly perhaps the hydrogen determinations, were in error. It would seem that both causes have been contributing to the discrepancies.

Dr. Hunicke urges that any complete set of data such as those in the government report must bear the searching test of a balance sheet, not only of the B.t.u's., but also the chemical masses which enter into the process. There seems certainly to be some unjustifiable element of uncertainty, due either to the analyses of the fuels or else those of the flue gases.

Greater care should doubtless be exercised in the chemical work of such extended series of boiler tests as those of the U. S. Survey, because it is impossible to foresee what information may at any time afterward be drawn from the data. However technical may be the work in its grosser features, elements which are measured should be measured with precision. It is to be hoped that in the future more powerful methods will be brought to bear on the problem in order to ensure not only accuracy of a high order, but also data which will most certainly yield information urgently needed as the competition between the different methods of fuel utilization becomes more keen.

Carbon dioxide recorders are doubtless invaluable as important elements in the recording of the performance of boiler plants, but we cannot for the present hope to gain information in greater detail than that most valuable instrument already records, unless technical research be directed to throw more light on the subject.

The American Institute of Chemical Engineers.

In the evening session of Monday, Dr. Charles P. Sadtler, consulting chemical engineer, of Philadelphia, presented in his presidential address "some thoughts on the organization of the American Institute of Chemical Engineers."

While Great Britain has five different national chemical societies and Germany three, the American Chemical Society in this country has been able to hold together in a more successful way all kinds and styles of chemists, the only notable exception being represented by the American Electrochemical Society.

"But while we heartily rejoice that the American Chemical Society includes in its membership such a general representation of chemists of all kinds and tastes, there is another phase of the question that must not be overlooked."

While scientific education should be on broad lines, there are many problems and interests that for their consideration require a degree of concentration and specialization. Most of the great industries involving chemical applications that have been built up and placed upon a basis that makes their present working lucrative, have achieved their success by the combined utilization of chemical knowledge, engineering skill and good judgment in the application of both.

These great industries, moreover, are not stationary in the conditions of their practice. The same chemical knowledge, engineering skill and good judgment must continue to be applied as advances are made in the sciences, or they will fall behind in the industrial competition.

There must, therefore, be a body of men supplied in increasing numbers who can take the technical charge of these industries, first as aides and ultimately as managers of the several works, qualified to continue the successful administration of the same and able to push them steadily to fuller development along safe and profitable lines.

The young graduate of the ordinary college or university course is not able to take up such work successfully, but it would be wrong to deprecate on that account scientific education and the value of college training. Yet we must realize that the applications of chemistry in the modern industrial arts, other than the metallurgical industries, are wider and more far-reaching than can be solved by the simple practice of the art of analytical chemistry, or application of the methods of chemical research learned in a university laboratory in connection with the writing of a thesis.

To be properly equipped for successful work in management and development of many industrial chemical processes, notably those utilizing organic materials, the chemist needs a more intimate acquaintance with the raw materials of the industry, whether fibers, cereals, gums, oils or resins, and the physical and chemical properties that are distinctive in each case, than is commonly obtainable in a college course of instruction.

Then, a knowledge of the laws of physical chemistry as affecting solution, reactions in the reversibility of the same under varying conditions, crystallization, and precipitation, has become recognized as of supreme importance, as the bearing and application of these laws to practical manufacturing problems has been pointed out.

Numerous applications of physical laws, mainly in connection with the application or utilization of heat, such as the question of steam raising, condensation and evaporation under normal and reduced pressure, or in connection with the development and utilization of electricity in factory practice, are also elements for the training of the technical chemist of to-day.

While, therefore, good analysts are and will continue to be in demand, there is also a present and prospective need for what, for want of a better title, we call "chemical engineers" to take responsible positions.

For these men the American Institute of Chemical Engineers has been formed. It has been thought, however, that the new organization should not be merely a new chemical society, open to all who were interested in applied chemistry, but the membership, should be carefully restricted as to experience, age and occupation.

With reference to the name, it seemed to the majority of those connected with the organization of the new institute that the name "American Institute of Chemical Engineers" had certain distinct advantages and justification. The title of engineer is no longer limited and used to designate a narrow profession, but is rather a term of broad application used by those who, with proper preparation and training, are occupied with the study of the problems of a wide range of industries. Following the original division, now a very broad one, into civil and mechanical engineers, we have had the organization of mining engineers, electrical engineers, sanitary engineers, not to speak of hydraulic and marine engineers. Why should not those who devote themselves to the construction, development and management of chemical manufacturing works take for

—*Photo by Gutekunst.*

SAM. P. SADTLER,
PRESIDENT AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.

themselves the name of chemical engineers? By establishing an age limit and strict standards of qualifications for admission, the title is dignified and not made cheap.

It is probably within the experience of most chemical engineers that they have been asked to help both civil and mechanical engineers, who have been called upon for solutions of problems of public interest, but find themselves weak on the chemical questions involved. Why should the chemical engineers not strive to develop an organization from whose ranks experts could be taken when the occasion arises, thoroughly competent to advise upon all questions of the applications of chemistry for useful purposes, the abating of nuisances by chemical agencies, or the utilization of natural resources by means involving chemical processes.

To raise the professional standard among chemical engineers, to discourage and prohibit unprofessional conduct, is also a matter in which the individual has a personal interest.

The promotion of pleasant acquaintances and social professional intercourse among the members is an element of value at all meetings of societies, but it is more generally realized in organizations of limited or selected membership as in certain clubs than in the meetings of large organizations. The special field of industrial chemistry will bring together men of common interests and yet be broad enough to furnish the diversity and newness of presentation that will attract the members and give them something to repay their coming together. Both the social side and the professional side can be advantageously cultivated in such a gathering.

The papers presented at the meetings, together with the discussions, shall be printed in volumes of *Proceedings*. The institute shall also encourage the preparations of monographs or collective publications on selected topics of importance in industrial chemistry. There are numerous subjects of live inter-

est to all chemical technologists that could be taken up in this way. For instance, a collection and classifying of the most important publications from various journals on the contact-sulphuric acid process, beginning with the paper of Knietsch, presented to the German Chemical Society in 1901, and noting the most important patents and published discussions on the subject down to date, would make something that would be of value to all members and would also be worthy of publication in the name of the institute. The same could be said of the still newer topic of such universal interest to chemists, viz., the fixation of atmospheric nitrogen, or the older, but nevertheless, important object of the by-product oven and its possibilities.

Finally, it is hoped that studies on subjects of technical importance can be encouraged by the establishment of prizes or medals to be awarded statedly by the institute.

* * *

Pulverized Fuel for Industrial Furnaces.

Mr. RICHARD K. MEADE, of Nazareth, Pa., delivered a lecture, illustrated by many lantern slides, on the use of pulverized fuel for heating industrial furnaces.

In view of the fact that practically all the Portland cement at the present time manufactured in this country is burned with pulverized coal and that this fuel is also used for the nodulizing of fine iron ores, it seems strange that this method of heating furnaces has not been more generally used in industrial and metallurgical work. The chief advantage is that it is possible to burn powdered fuel with almost the exact amount of air necessary for combustion. This means the possibility of producing a higher temperature than with producer gas and solid coal; it also means a considerable saving

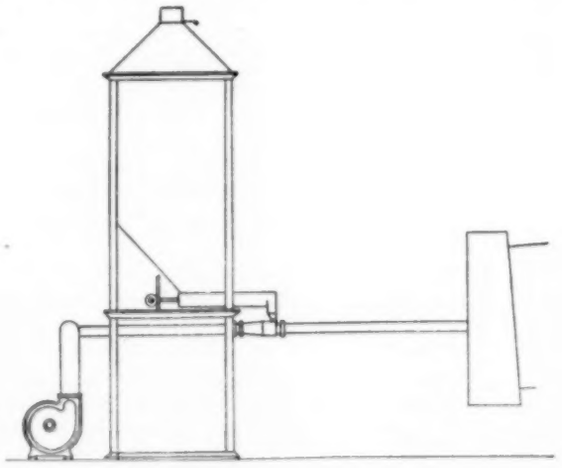


FIG. 1.—BURNING POWDERED COAL.

of coal, due to the smaller amount of excess air used. The carbon is completely burned, no carbon being left in the ash.

Furthermore, practically all the carbon is burned to carbon dioxide, avoiding losses due to incomplete combustion to carbon monoxide. Powdered coal has the advantage over gas firing in that the inherent losses of the gas producer are overcome. Mr. Meade estimates that the loss in gas producers may generally be considered as 30 per cent of the thermal value of the coal.

One objection to powdered coal is the danger of explosion. But this is true only for powdered coal suspended in air. Powdered coal *en masse*—that is, when it is in a pile or in a bin—burns very slowly and with absolutely no explosive effects. The main point is to avoid the coal dust being stirred up and mixed with air.

The department of the plant in which the coal is ground should be always well ventilated so that no gas can accumulate. This can be accomplished by the use of a monitor running the full length of the roof and having slatted sides. Reinforced concrete offers a splendid material for the construction of fuel mill buildings, as the walls are straight and there are no projections to catch dust. The pulverizing department should be fireproof and located with at least an alley between it and the other parts of the mill. No naked lights should be allowed in this building.

When fires occur in grinding mills they may be best extinguished by the use of a tube of liquid sulphur dioxide kept for the purpose, or they may be smothered by steam. All this is by way of precaution only, however, as fires now rarely occur in fuel mills.

Coal-dust heating is well suited to obtaining high temperatures in open hearths. It is possible with this method of

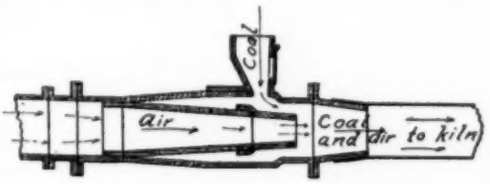


FIG. 2.—INJECTOR FOR LOW-PRESSURE AIR.

firing to get as long a flame as can be obtained with any other. The system was tried on a reverberatory furnace at Murray, Utah, and here it was said that it was possible when allowed to do so for the flame to heat and slag the stack brick.

With a rotary cement kiln 60 ft. long it is possible by closing all dampers to obtain a flame almost the entire length of the kiln. It is also possible by finely pulverizing the coal and using a damper to concentrate the flame within the first 20 ft. This makes the coal-dust flame one which may be very easily regulated so as to heat most strongly just that part of the charge which it is desired to have hottest.

The settling of the ash upon the charge is not considered by Mr. Meade to be serious, since the particles of ash, while occupying practically the same volume as the coal, have only from 10 to 20 per cent the weight of the latter and are therefore

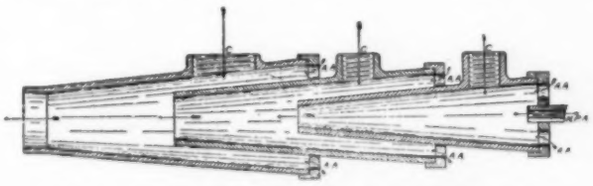


FIG. 3.—COMPOUND BURNER FOR HIGH-PRESSURE AIR.

chiefly carried off by the strong draft which exists in most furnaces.

Where regenerative furnaces are used to heat the air for combustion, this ash, of course, may collect in the checkerwork of these. Where pulverized fuel is used for burning, therefore, the regenerators should be designed with large ash settling chambers and wide passages in the checkerwork. Damour and Queneau in their treatise on industrial furnaces give as their opinion that parallel counter-current regenerators are well adapted for use with furnaces heated by pulverized coal. These regenerators avoid the use of valves, and it is possible with them to clean out the passages for the waste products by a jet of steam or compressed air or even with small and sharp water jets. Just enough water should be injected to have instantaneous vaporization. If this is to be done care must be exercised to use in the regenerators such fire brick which will stand sudden cooling without "spalling." For such regenerators a design similar to a blast furnace hot stove would be advantageous, as these, being formed of a series of thin solid walls, are easy to clean.

In coal-dust firing the best results are obtained in a chamber in contact with highly heated material such as firebrick. If the flame, on the other hand, comes in contact with a cold surface

such as boiler tubes the latter will reduce the temperature of the fuel and the air below the ignition point, resulting in incomplete combustion. For this reason heretofore coal-dust firing of boilers has not been used successfully, but there is no reason why, if the proper types of furnaces are used in connection with certain types of boiler, this system of burning pulverized coal in connection with boilers should not be successful. In the case of metallurgical furnaces, however, where the firebrick and charge are both at a high temperature, combustion is complete and very rapid.

Coals rich in volatile matter such as gas coal and lignite are best suited to pulverized firing.

As to the stack, with pulverized fuel all that is needed is sufficient draft to draw the products of combustion through the furnace with the desired velocity, which can usually be accomplished by the use of a short stack.

The method of preparing the coal for burning consists first in crushing it roughly between rolls or in a small pot crusher, and then drying and powdering it so fine that from 90 to 95 per cent of it will pass through a sieve having 100 meshes to a linear inch.

In order to get the greatest efficiency from the pulverizing machinery, it is necessary to dry the coal until it contains less than 1 per cent moisture. This is mostly done in inclined rotary-cylinder dryers.

Mr. Meade showed lantern slides of the Matcham coal dryer, made by the Fuller Engineering Co., of Allentown, and also described dryers of the Ruggles-Coles Engineering Co., the F. D. Cummer & Son Co., and the C. O. Bartlett & Snow Co.

Where the coal has been passed through a screen and consists of only pea and slack size, crushing is unnecessary. One of the best forms of pot crushers is what is known as a "coffee mill cracker."

When a set of rolls is placed before the dryer they are of the toothed form, such as are used to crush run of mine coal. These rolls are usually about 24 in. in diameter, with a 30-in. face.

When the rolls are placed after the dryer to prepare coal for a tube mill they should be plain faced or only slightly corrugated. The toothed rolls usually reduce run of mine coal to 2-in. lumps and under, and the plain-face rolls will crush to lumps ranging from ½ in. down.

When coal is first passed through a screen and consists of only pea and slack size, rolls and pot crushers are unnecessary. After being reduced to 1-in. lumps and under, the coal may be ground to the necessary fineness directly by either Fuller-Lehigh mills, or Griffin mills, or tube mills, preceded by some form of preparatory mill, such as a Williams mill, a Steadman cage disintegrator or a set of smooth-faced rolls. Several of these mills were described and shown in lantern slides.

The method for burning powdered coal is shown in Fig. 1. It consists of an injector, through which the air is forced by a pressure blower at a pressure of about 0.6 lb. The coal is conveyed out of a bin by a screw conveyor, falls into the injector, is sucked in and mingles with the air as it passes through the pipe to the furnace.

The injector is usually of cast iron, the pipe leading to the furnace is of galvanized iron and terminates in a nozzle of wrought-iron pipe, which projects for a foot or more through the hood into the furnace. The screw conveyor leading from the bin is run usually by a line shaft attached to the fan or the motor driving fans. The connection with the shaft is made either by some form of speed controller, or else by a stepped pulley, so the coal feed can be regulated.

The air blown in is usually constant and may be varied from only a fraction of that needed for combustion to the complete amount. In some cases air from the compressors or high-pressure air is used, and in others a combination of the two is sought. The main object in any event is usually to carry the coal into the furnace and to get a good mixture of coal and air, the rest of the air being drawn in by the draft.

Fig. 2 shows the construction of an injector for use with low-pressure air. The construction of the burner is evident from the drawing.

Fig. 3 shows a compound burner intended for use with high-pressure air. The coal drops down at the three points, *C*, *C* and *C*, the air from the compressor enters at *H P A*, and a certain amount of atmospheric air is sucked in at the openings, *A A*. As to the relative merits of the two, the low-pressure air is much the simpler of the two where a compressor would have to be installed.

With the low-pressure system it has been found best to blow into the kiln at least 20 per cent of the air necessary for combustion with the coal. With the high-pressure air, however, only about 5 per cent of the necessary air is obtained from the compressor. This air is usually delivered to the burner at about 80 lb. pressure.

Now, to burn 100 tons of gas slack per day, about 4000 cu. ft. of low-pressure air, or 1000 cu. ft. of high-pressure air, per minute will be needed. The theoretical horsepower required to supply 4000 cu. ft. of air at 1 oz. pressure amounts to 1.4 hp. To compress 1000 cu. ft. of air to 80 lb. pressure, 137 hp will be theoretically required. Hence there is considerable saving in the use of low-pressure air.

Mr. C. A. Matcham has recently invented a system of burning powdered fuel, which makes use of the natural draft of the furnace to suck the coal in. About 0.4 to 0.6 in. of water draft is needed for this system.

Finally, Mr. Meade gave some estimates of the cost of preparing pulverized coal and of the cost of operation of such a plant.

* * *

Pyrometers.

Dr. Edwin F. Northrup, of Philadelphia, partner of the firm of Leeds & Northrup, presented a paper on modern resistance pyrometry.

All temperature scales are ultimately referred back to the gas thermometer scale and comparison is made indirectly with the aid of the melting points of a series of pure metals (gold 1060° ± 1° C., A. L. Day and J. K. Clement; platinum 1753° C., Bureau of Standards). The constant-volume nitrogen gas thermometer is reliable in the region from 300° C. to 1150° C. to ½° C.

A distinction must be made between the sensitiveness and the accuracy of a pyrometer. A pyrometer may be exceedingly sensitive to note changes in temperature and constant in its performance, and yet give no certain indications of actual temperatures. A pyrometer of this character may be useful in enabling one to repeat temperatures, as shown on an arbitrary scale, which have been found by trial to be most suited to a given process.

These relative measurements of temperature have, however, two important disadvantags and limitations over absolute measurements. First, many manufacturing plants have several branches in different sections of the country, each branch making the same product by like processes. If at one branch it is found by trial that the best results are obtained when a particular pyrometer gives certain indications on an arbitrary scale, these results cannot be interpreted so as to be communicated to the other branches of the plant. Thus, each branch must learn by its own experimenting.

Second, if the particular instrument is broken or goes out of calibration, the whole process of experimentation must be repeated with a new instrument or scale having a different constant. This seemingly obvious consideration shows the great desirability of having pyrometers read accurately in actual degrees Centigrade or Fahrenheit and not merely scale divisions which are relatively correct, but not capable of being interpreted in actual temperature degrees.

Foremen often believe that they have trained their eyes quite accurately to judge temperatures with sufficient exactness. But

the condition of the light, retinal fatigue and imperfect memory all influence estimates of this kind to such an extent as to make them practically valueless.

Foremen and workingmen are often opposed to the use of pyrometers because they believe them to be "too complicated, too delicate, and unreliable." The question arises where to find the source of unreliability. Any electric pyrometer (whether of the resistance or the thermoelectric type) contains the "bulbs" located at the points the temperature of which is desired; the indicator with which the temperature of the bulbs is read, and the system of wires which join the bulbs with the indicator. The bulbs, so to speak, are the finger tips that feel the temperatures, and the wires are the nerves that put these into communication with the interpreting indicator, the brain. Defects in the bulbs, or in the indicator, give false temperatures, and defects, such as opens, crosses, grounds and leaks, on the connecting wires stop or falsify the communication between bulbs and indicator.

Of these parts, the indicator and the resistance thermometer bulb have been worked out by the manufacturer until they are no longer fragile, inconstant or unreliable. But, however well these may be constructed, electrical resistance pyrometers will continue to be unreliable unless the wiring system where they are installed is properly done and properly cared for.

If a mechanical engineer wishes to transmit 10 hp across a factory, he puts up in a substantial manner a line of shafting and it stays in order. An electrical engineer could carry the same power across the factory with a single wire, the diameter of a pin, laid on the floor.

He can thus with slight effort get his results at once and the temptation is great to put up flimsy, uncertain wiring, but such transmissions are short-lived, and it is then, indeed, invidious to say, as is often done, that electrical installations cannot be relied upon like mechanical installations. If the 10 hp were carried in a lead-incased cable, as substantially supported as the shafting, and as carefully connected to generator and motor at its ends as is the shafting, the electrical transmission would remain in operation when a line of shafting and belts had rusted and rotted into uselessness.

The conclusion of this is that electrical resistance pyrometers are not only capable of being very accurate within 2 to 5 deg. at 1200° C., but can be made entirely reliable, if they are installed with like care that is put upon important mechanical installations. As the methods worked out for such proper installation is the busines of experts in pyrometer work, no plant should be installed without following wiring diagrams and full instructions given by such experts.

No fixed design of pyrometer is suitable for all different manufacturing purposes. The resistance thermometer has its limitation in the measurement of high temperatures at a temperature around 1200° C. Above this temperature, the platinum wire used slowly volatilizes, producing a slow but continuous increase in the resistance at a given temperature of the resistance wire. Below this temperature, down to that of liquid air, the resistance thermometer is, in the author's judgment, more accurate, more reliable and capable of utilizing more energy than the thermocouple. Above 1200° C. and below 1600° C. the platinum, platinum plus 10 per cent rhodium thermocouple will take its place. Above 1600° C. radiation or optical pyrometers must be used.

As already stated, for temperatures below 1200° C., some form of the resistance pyrometer is generally most suitable. But these vary in many respects, the most important one being the kind of protecting case which must be used so that the pyrometer will be accurate and quickly assume its temperature, and yet be so protected as not to be easily injured or destroyed by rough usage or handling. Thus, a pyrometer merely encased in a porcelain tube might serve well if permanently inserted in flue gas, but be useless for taking the temperature of molten lead in kettles. Prospective purchasers cannot be urged too strongly, for their own interest, to furnish sufficient information to the manufacturer of pyrometers to enable him to give adequate advice on the best solution of the engineering problem to be met.

The charge of unreliability might have been made in the past with greater justification against the recording devices used with recording pyrometers than against the pyrometers. But in the latest design reliability of the recorder has also been obtained.

In the concluding part of his paper, Dr. Northrup described the many fields of applicability of pyrometers. One particularly interesting application was made in connection with the recent tunnel building under harbors and rivers by the Pennsylvania Railroad. At the foot of East Thirty-fifth Street, New York, a tunnel of small diameter was run underneath a part of the East River. By means of pipes laid in this tunnel, brine at about —35° C. was circulated for months in the tunnel. Its low temperature abstracted the heat from the walls of the small tunnel, freezing in cylindrical zones the silty soil. The frozen material thus formed a hard, self-supporting mass which would permit the enlargement of the small pilot tunnel to its full required diameter. The progress of the freezing was observed by hundreds of resistance thermometers located in the soil at varying distances from the axis of the tunnel. The difference in temperatures of the entering and leaving brine—a difference of less than 4° C.—was registered to an accuracy of 0.01° C. by means of resistance thermometers and their registrations were photographically recorded, without interruption for months. The measurements of temperature by means of electrical resistance thermometers in this experiment were entirely successful and accordant.

It is in glass-annealing ovens and leers that the resistance pyrometer finds itself in most congenial temperatures, and renders a most valuable record. If the glass in the ovens gets too hot it melts in the ovens. If it gets too cool, it cracks in customer's hands and complaints and replacements or loss of business occur. In a typical installation in a large glass works, several pyrometers are permanently installed in the ovens and leers. A deflection type indicator, which by turning a single handle is switched upon any pyrometer, tells the foreman how his heat is running. A dial indicator in the superintendent's office enables the temperatures of the same pyrometers to be read there at the same time, and an autographic recorder may be switched upon any oven and give the history of its temperature run in the form of a perfect ink record. This is drawn upon a long sheet of cross-section paper, 10 in. wide, which may be cut up into lengths of 6 ft., each representing runs of 24 hours, and filed for future reference.

In closing, Dr. Northrup said that the theory of resistance pyrometers is fully developed and shows the possibility of rigidly accurate results being obtained; the engineering details have been developed so all temperatures from that of liquid air to 1200° C. may be both accurately indicated and recorded, and lastly, these results can be actually obtained in practice and, indeed, are now obtained, with installations which are reliable, in defiance of the prevalent opinion to the contrary. But to make the last statement true, intelligence of a good order must be used all along the line from the manufacturing and calibrating of the instrument to their adequate and proper installation. If intelligence is used thus far, very ordinary persons can use the instruments and understand their indications. Though, even here, in the case of large installations of many pyrometers, it is of doubtful commercial economy not to employ, with suitable recompense, trained persons who are fully capable of using apparatus which is so difficult to render entirely "fool-proof."

* * *

Liquid Ammonia.

Dr. F. W. FRERICHS, of St. Louis, Mo., presented a paper on apparatus for testing liquefied ammonia gas.

A review was given of the devices now in use in this country and abroad, and it was pointed out that a source of error inherent in some of them was the moisture contained in the atmosphere, which could not be excluded from the sample. The new apparatus excludes this error entirely and its accuracy was

demonstrated by repeating the experiments of Lange and Heffter (*Chemische Industrie*, 1898, page 2), with liquefied ammonia gas of the greatest prity, and also with mixtures of this ammonia with known quantities of benzole, pyridine, alcohol and water.

The liquefied ammonia gas used in these tests had been made from sulphate of ammonium previously purified from all volatile carbon compounds. For this reason it was certain that no carbon compounds like benzole, pyridine, alcohol, etc., could be present, and the limit of water was ascertained (by treatment with metallic sodium and measuring the hydrogen evolved) to be less than 0.002 per cent.

The average of five analyses made in the new apparatus of this ammonia showed it upon evaporation to leave a residue of not more than 0.00175 per cent, consisting principally of water, iron oxide and lubricating oil, while Lange and Heffter, using Urban's method, have worked with liquefied ammonia gas leaving upon evaporation 0.2 per cent of a non-volatile residue.

Evaporation test of pure liquefied ammonia gas containing known quantities of benzole, pyridine, ethyl alcohol or water:

Substances present.	Liquid NH_3. Grams.	Addition. Grams.	Addition evaporated. Per cent. by Urban.	Per cent. by Frerichs.
Benzole and pyridine	99.0	1.0	..	15
Benzole	98.5	1.5	41	59
Pyridine	99.0	1.0	33	24
Ethyl alcohol	99.0	1.0	20	17
Water	98.9	1.1	17	11

Used ammonia leaving upon evaporation. Per cent.	
0.2	None

The limit of accuracy of testing with the new apparatus has been ascertained as follows:

For water to .....0.002 per cent.
For alcohol to .....0.006 " "
For pyridine to .....0.009 " "
For benzol to .....0.110 " "

The new process of Dr. Frerichs (United States patent 905,-415, Dec. 1, 1908) for making pure liquid ammonia is about to be tried on a large scale. Its essential features are as follows: Commercial sulphate of ammonium is heated in a still to about 200° C.—a temperature sufficiently high to volatilize the carbon compounds in the salt and to convert the nitrogenous-organic compounds into sulphate of ammonium by reacting with the sulphuric acid of the ammonium salt. No considerable quantities of ammonia gas are thereby liberated from the salt. To facilitate the process of purification, an air blast may be introduced in the still. After this purification process is over, the temperature is raised to 350°, to get the reaction

$$(NH_4)_2 SO_4 = NH_4 HSO_4 + NH_3.$$

If the temperature is further raised to 400° C., the reaction is quickened. No ammonia is destroyed, but the acid sulphate of ammonium is decomposed into pyrosulphate of ammonium and water:

$$2\,NH_4 HSO_4 = (NH_4)_2 S_2O + H_2O.$$

The resulting pure ammonia gas is then worked into the desired products, while the acid sulphate of ammonium and pyrosulphate of ammonium resulting from the operation are dissolved in water, and the resulting solution of acid sulphate of ammonium is utilized for absorbing volatile ammonium compounds and impure ammonia gas coming from crude ammoniacal liquors during the initial distillation thereof or otherwise obtained. This completes the circle of operation, the sulphate of ammonia thus obtained being treated as before.

* * *

Tuesday Evening Session.

In the evening session Dr. J. Herbert Brewster presented a very interesting paper on "the sanitary condition of the southern end of Lake Michigan." The paper was illustrated by lantern slides, and gave a review of an extended investigation, revealing a horrible state of affairs due to the contamination of the water by a glucose factory, several sewers, etc. The currents of the different contaminated streams were carefully traced. The author also discussed possible remedies.

Of equal interest, though of an entirely different nature, was the paper by Dr. William M. Grosvenor, consulting chemical engineer, of New York City, on "dryer calculations and dryer designs." The paper went right to the root of the matter, giving the fundamental thermodynamics of the drying process. The paper was illustrated by various elaborate diagrams. We hope to publish this paper in full in a later issue.

Mr. Thorn Smith's interesting contact-process paper was read, in absence of the author, by the secretary. It gave an account of some experiments with the ferric iron contact method of making sulphuric acid from smelter fumes. We reserve an abstract for a later issue.

The other papers were read by title. We quote their titles from the printed program:

"Testing and Performance of Steam Generating Apparatus," A. Bement.

"Producer-Gas Installations," Ernest Schmatolla.

"Work of the United States Government Fuel Testing Plant at Denver, Col.," A. W. Belden.

"Chemical Specifications for Sulphite Pulp," J. A. De Cew.

"Cement Manufacturing Methods," J. G. Dean.

After the usual vote of thanks the meeting adjourned.

The secretary of the American Institute of Chemical Engineers is Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

Transport of Ferrosilicon.

The English press, technical and otherwise, is again full of remarks on the dangers of ferrosilicon. The death of five men in the emigrants' quarters of the steamship *Ashton* occurred in a peculiar way, as follows: Five Russian emigrants left Antwerp by the *Ashton* on Dec. 12, and the same evening were seen to be suffering from what was naturally assumed to be seasickness. The next morning four of the five were discovered dead and the other one was in a dying condition.

The emigrants were berthed between decks and directly above the forehold, which contained, among other things, nine tons of ferrosilicon in barrels. A hatchway gave communication between the places. When the master of the vessel went down he detected no unusual smell, but was very ill after the visit. He sent for the port authorities on arrival in the harbor, and the sanitary officer noticed a smell which he did not recognize at the time, but afterwards knew to be "that of ferrosilicon." The forehold, where the stuff was stored, was perfectly dry, and the ship was passed A1 at Lloyd's three months ago.

Evidence was given by Mr. J. A. Foster, analytical chemist, of Hull, to the effect that the ferrosilicon contained besides iron and silicon also carbon, phosphorus and arsenic. Five gases were given off, namely: arseniuretted hydrogen, phosphoretted hydrogen, acetylene, pure hydrogen and sulphuretted hydrogen. Pure hydrogen, the witness said, was of an asphyxiating nature, and the other gases were very poisonous, arseniuretted hydrogen being most intensely so, a single bubble having been known to cause death. Phosphoretted hydrogen was nearly as deadly. In less than 24 hours the nine tons of ferrosilicon, if dry, would give off 110 cu. ft. of extremely deadly gas; and if the stuff were moist, thrice that amount would be evolved. The gas given off by the ferrosilicon in the hold would have killed a hundred people. The early symptoms were liable to be mistaken for those of cholera or ptomaine poisoning. The gas decomposed the blood. Ferrosilicon was most treacherous; if sealed in drums it was liable to explode, and if cased in barrels it gave off the poisonous gases mentioned.

The Swedish government recommends that in passenger vessels, ferrosilicon, if carried, should be on the open deck and away from cabins, etc. It does not advise packing it in hermetically-sealed drums for fear of explosion. By railway it should travel in open trucks, covered with water-tight tarpaulin.

The Methods of the United States Steel Corporation for the Commercial Sampling and Analysis of Iron Ores.

(Copyright, 1908, by J. M. Camp, Chairman Chemists' Committee.)

Iron Ore Sampling in General.

Owing to the varying conditions under which iron ores must be sampled, both by the producer and the consumer, variations from any uniform procedure of sampling are necessitated. The elements of time, size of shipment, kind of ore and other considerations are determining factors in the details of procuring the sample. Hence it is the purpose to render the following methods general in their scope, promulgating those ideas applicable in the broader sense to ore sampling, without attempting to prescribe for every varying and unforeseen contingencies in the details.

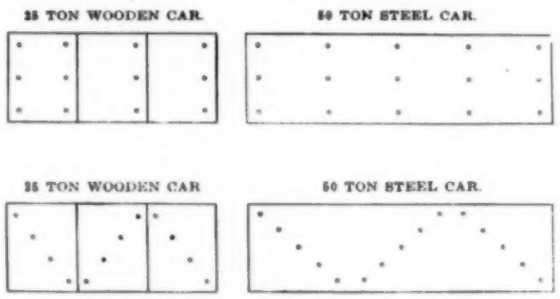


FIG. 1 (ABOVE).—PARALLEL SYSTEM.
FIG. 2 (BELOW).—ZIGZAG SYSTEM.

Car Sampling at Producer's End.

All samples must be taken uniformly over the surface of the cars after being loaded by taking a minimum of 12 places for wooden, and 15 places for steel cars, by either the parallel or the zigzag system. The above diagrams illustrate these two systems and show the minimum number of points where samples are to be taken.

When lumps of ore are encountered at the designated points where samples are to be taken, small portions of each lump must be chipped off, about equal in size to the first joint of the thumb. When rock occurs it must also be sampled as ore,

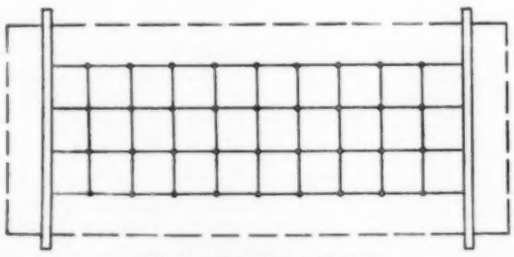


FIG. 3.—ROPE-NET SYSTEM.

that is, a proportionate amount of the rock or off-grade material is to be taken, not equal in amount to the regular sample for the area covered by that point, unless the entire area is such off-grade material. Then the same amount of adjacent material must be taken, or ore or rock, equal in amount to the portion taken at each regular point. This also applies to field boulders, unless thrown from cars.

The samples are taken with a garden trowel. Each 10 cars, either steel or wooden, must be combined, as a rule, into one sample; but less than 10 cars may be grouped. The weight of the sample must not run under 15 lb. for 10 wooden, and 20 lb. for 10 steel cars.

Whenever very lumpy ore is to be sampled in the cars, the rope net system is used, as shown above, which gives about 32 places on each car, the knots being 18 in. apart. In using the net system, if a lump of ore or rock comes directly under a knot, a piece should be taken about the size of the first joint of the thumb. If fine ore occurs under a knot, an equal amount is taken with the trowel. The rope net system is used at the Marquette Range on the hard, lump ore; also at the Soudan Mine, Vermilion Range.

A moisture sample must be taken for each train load from all open pit mines; a train consists of 40 to 45 of the 50-ton steel cars, or 60 to 68 of the 25-ton wooden cars. A moisture sample must also be taken for all the cars loaded at a shaft or stock-pile during each 10-hour shift. Samples must be taken from three places on top of each car, as shown by the following diagram.

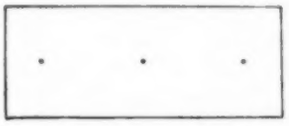


FIG. 4.—MOISTURE SAMPLING.

Care should be taken to secure the sample from well underneath the surface as soon as practicable after loading, maintaining the true proportion of lump and fine ore. The sample as taken must be immediately placed in a can with a tightly fitting lid, and brought to the crusher house. It is optional to take a moisture sample from the regular sample, provided it has been taken from well underneath the surface.

Cargo Sampling at Consumer's End.

Cargo ores present the most serious obstacles to a uniform method of sampling. The boats vary in size from 3000 to 12,000 tons, with one or two decks, and in the number of hatches from 6 to 36, with widths varying from 12 ft. to 24 ft. The grabs at the different unloading points vary in number, kind and size, and the rapidity of their operation. The ores vary from the very fine to the all-lump, from the so-called mixed ores, such as the groups to the mixed cargoes, consisting of different ores in the same boat, and with different ways of loading the boats.

Grab Sampling.—An excellent method of cargo sampling where the entire cargo will be represented, and particularly adaptable for fine ores, is called grab sampling. A sampler with a small scoop attached to a handle of suitable length and holding a definite amount of ore, a quarter, a half or a whole pound, takes a scoopful from each grab as it rises above the deck. The disadvantage of this system is its increased cost due to the extra number of samples, one being required for each grab during the entire time of unloading.

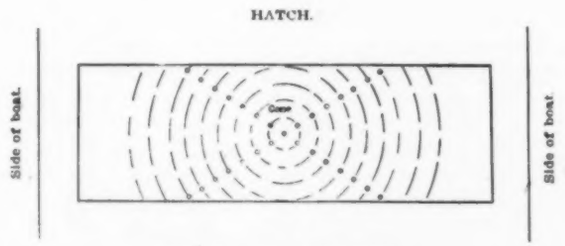


FIG. 5.—CONE SAMPLING.

The general plan for the sampling of all cargoes is to first sample the tops of the piles, before the grabs have started to unload; this is called sampling of the cones. After the grab has removed from the hatch all the ore within reach, the exposed faces standing on each side are sampled; this method is known as face sampling. Or when the latter practice is impracticable owing to the operation of the grabs, then the method of rounds is followed.

In sampling, a small shovel or garden trowel is used, the total length of which, including the handle, is 12 in., and it also constitutes a measure. It is the aim to take equal sized samples from each of the points selected. When lump ore or rock

is encountered at the point determined by the measure, a portion is broken off equal to the amount regularly taken.

In the sampling of the cones, at a point midway between the side and the center of the boat, directly under the edge of the hatch, the first sample is taken and sampling continued one shovel length apart up the surface of the cone, over its apex and down the opposite surface to a corresponding point under the other edge of the hatch. This line is crossed from corresponding opposite points under the hatch, as shown in the following sketch. Not more than one-tenth of the total sample is to be taken in the sampling of the cones.

Face Sampling.—After a grab has removed from a hatch all the ore within reach and has moved to another hatch, the sampler shall measure two shovel lengths from the side of the boat and start up the exposed face of the ore, taking samples one shovel length apart all the way to the top, using a ladder if necessary. The next vertical line is measured four shovel

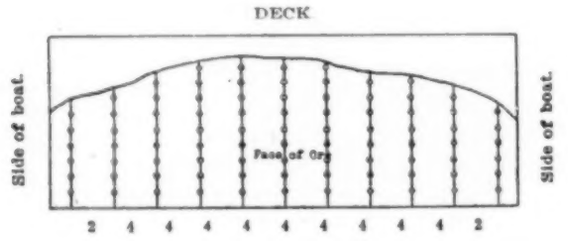


FIG. 6.—FACE SAMPLING.

lengths from the first and the samples taken each shovel length apart on this line as before, and so on for each succeeding line across the boat. This is repeated on the opposite ore face, and the entire procedure continued until the ore faces of all the hatches are sampled that the character of the boat and the operation of the grabs will permit. When a bulkhead occurs only the face opposite to it is to be sampled.

Round Sampling.—When the operation of the grabs makes sampling by the face method impracticable, or with boats having 24-ft. hatch centers, and decks furnishing protection to the samplers, then sampling shall be done while the ore is being removed by the grabs. When 5 ft. or 6 ft. of the face of the ore have been exposed, the sampler shall enter the hatch and measuring two shovel lengths from the side of the boat or edge of the face, take successive samples up the face one shovel length apart. The next vertical line is measured four shovel lengths from the first, and samples are taken all the way to the top as before, and so on across the entire face of the ore. This procedure is repeated on the opposite face, one-third of the total weight of the sample to be taken in the first round. When all the ore within reach of the grab is removed, the second round is taken, using the measurements as above, and the remaining two-thirds of the sample are secured.

Part of the regular sample is to be taken for the moisture sample, and for the fineness sample when such is desired.

Car Sampling at Consumer's End.

When the ore is received in cars the greatest possible number are represented in the samples, and not less than 10 equal-sized samples are taken from each car. When cars are loaded with fine ore, with the piles in opposite ends, at least five samples are taken from each pile, the first one at the apex of the pile, and the other four at points symmetrically arranged around the sides of the pile, two-thirds of the distance from the apex to the base of the pile or sides of the car. With cars loaded in the center, the system is the same, except that the center of the side of the pile lengthwise of the car is the first point, the other four being symmetrically arranged around this point.

When the 10 points are located in a car, each of them is supposed to represent a definite area, equal to one-tenth of the ore surface of the car. If the car contains all fine ore, then 10 equal-sized samples are taken, one from each of the points. If the car contains a mixture of fine and lump ore, with varying amounts of each in the areas included in the different divisions, then each area is judged separately and sampled accordingly. The fine and lump ore are taken each in its proper proportion, the former with the trowel, the latter being shipped or selected small pieces being taken, each about the size of the first joint of the thumb. The combined sample of fine, chipped and selected pieces from each area equals the amount taken were it all fine ore. If the contents of the car are all lump ore, the proper sized pieces are chipped from four or five lumps in each of the 10 areas, making 40 or 50 pieces from each car, the total amount of chipped pieces from each of the areas equalling the amount that would be taken were it all fine ore. All samples of fine ore are taken from well underneath the surface to obtain the ore in its natural state.

A proportionate amount of the main sample is retained in a tightly closed can for the moisture determination.

Preparation of Samples in General.

In the preparation of the sample for analysis, the ideal practice is to crush and quarter alternately until the desired quantity with the requisite degree of fineness is attained. A more expeditious and equally efficient method, is to crush the entire sample to the desired degree of comminution, then reduce the quantity by successive quartering as before, until the desired amount remains. It should ever be our purpose to approach as closely as possible to either of these two methods in the preparation of all samples for analysis.

Preparation of Sample at Producer's End.

Samples before being quartered are brought into the crusher house, where they are dried, if necessary, at 100° C., until the ore can be well mixed. Care must be taken to prevent overheating when other than low-pressure steam is used for the purpose, especially with ores containing a large quantity of limonite. When sufficiently dry the larger lumps are crushed, if necessary, so that the entire sample will pass through a ½-in. mesh sieve; a finer sieve may be used if desired. The sample is thoroughly mixed on an iron-top table, then spread out evenly about three-fourths of an inch in depth and alternately quartered and mixed until one-fourth of the original sample remains. It is now crushed until fine enough to pass a ¼-in. mesh sieve, then mixed and quartered as before until about 2 lb. remain. It is again crushed until fine enough to pass a 20-mesh sieve, and spread out evenly about ⅛ in. in depth. About 3 oz. of this is taken from all over the pile, with a small spatula, dried in a small pan at 100° C. and crushed on a chrome-steel plate, until it will all pass through a 100-mesh sieve. After being thoroughly mixed this is transferred to a bottle, and constitutes the sample for analysis.

The following method for the preparation of the sample is optional: All the ore is passed through a ½-in. sieve, thoroughly mixed on a suitable cloth and quartered in the usual way, diagonally opposite portions being rejected until about 5 lb. remain. The sample is again crushed, if need be, to pass a ¼-in. mesh sieve, and mixed and quartered as before until 1½ to 2 lb. remain. After being dried at 100° C. for 20 to 30 minutes, it is crushed to a fineness of 20 mesh, mixed and quartered until about 3 oz. remain, and the entire sample is crushed on a chrome-steel plate and passed through a 100-mesh sieve. This sample is spread out in a shallow pan, dried at 100° C. for 30 minutes, again mixed and transferred to a 3-oz. bottle or can for the analysis.

Preparation of Sample at Consumer's End.

The aggregate sample is dried at 100° C. and crushed before any quartering whatsoever, so that the entire mass will pass through a ½-in. mesh sieve. This is reduced by successive quartering and crushing until its weight is from 4 to 8 oz., and it will then all pass through an ⅛-in. mesh sieve. Or the entire sample is crushed so it will pass through an ⅛-in. mesh sieve,

and then quartered as before until from 4 to 8 oz. remain. And this final quantity is then further crushed with a chrome-steel bucking board and muller and all passed through a 100-mesh sieve. A sufficient amount of this powder for all the needs of the analyst is placed in a small air-tight container, dried for one hour at 100° C. and when cool it constitutes the sample for analysis. A separate, larger portion of the same sample is retained for further needs.

Iron.

BY THE BICHROMATE OR PERMANGANATE METHODS.

One or more portions of ½ to 1 gram of the ore are placed in a beaker and 5 to 10 cc of the solution of stannous chloride and 5 to 25 cc of strong hydrochloric acid are added. This variation in the amount of acid is due, aside from the variations in the weight of the sample and the varying solubilities of the ores, to the fact that while in the permanganate method the minimum amount of free acid should be present, with the bichromate method an excess of acid is essential. The beaker is covered with a watch glass and heated gently on the steam bath, or hot plate, until all iron is dissolved, and if the permanganate method is to be used, the volume of the solution is reduced by evaporation so as not to exceed 10 cc. While still hot the stannous chloride solution is added from a burette, drop by drop until the color due to the ferric chloride just disappears, and then one drop in excess. The solution is diluted to about 350 cc with cold water, 5 cc of mercuric chloride solution are added and the solution is thoroughly stirred. From this point the bichromate or permanganate titrations are optional. In the former case, the potassium bichromate solution is added from a burette until a drop of the solution being titrated, added to a drop of the potassium ferricyanide solution on a paraffined plate shows no ferrous iron. In the latter case, 10 cc of the titrating solution are added for a ½-gram sample, and 20 cc for 1 gram. The solution is stirred and titrated with the potassium permanganate. In either case, the number of cc used multiplied by the respective factor gives the percentage of iron.

If the residue is suspected of containing iron it is filtered off, ignited and fused; the fusion is dissolved in water, acidified with hydrochloric acid, and the solution reduced and titrated as above; or the solution before being acidified is filtered, the ferric oxide on the filter is dissolved in hydrochloric acid and added to the main solution or titrated separately.

Solutions for Iron Titrations.

The stannous chloride solution is made by dissolving 250 grams of the salt in 500 cc of strong hydrochloric acid, and diluting to 1000 cc.

The mercuric chloride solution is saturated in the cold.

The potassium ferricyanide solution is made fresh each day by dissolving in the proportion of 0.100 gram of the salt in 100 cc of water.

The potassium bichromate solution is made by dissolving the salt in the proportion of about 8.9 grams to 1 liter of water, and standardizing with an iron ore, iron wire or steel of known iron content. One cc equals approximately 1 per cent iron with a 1-gram sample taken for analysis.

The titrating solution is made up in the following proportion to the liter: 90 grams of manganous sulphate are dissolved in 650 cc of water, 175 cc of strong sulphuric acid are added, then 175 cc of phosphoric acid of 1.75 specific gravity, and the solution is filtered if necessary.

The permanganate solution is made by dissolving the salt in the proportion of about 5.7 grams to 1 liter of water and standardizing in the same manner as the bichromate solution. One cc equals approximately 1 per cent iron with a 1-gram sample taken for analysis.

Silica.

USING 1 GRAM WITH HYDROFLUORIC EVAPORATION.

One gram of the sample is transferred to a porcelain dish, or a beaker, with watch-glass cover, and 20 cc of strong hydrochloric acid are added. A gentle heat is applied until the ore is dissolved and the solution is then evaporated to dryness, unless it has been conclusively shown to be unnecessary. (See footnote.*) To the residue, which should not be heated above 120° C., 15 cc of dilute hydrochloric acid (1 part acid to 1 part water) are added, heat is applied until the salts are dissolved and the solution is diluted with hot water. The precipitate is filtered off, washed, ignited at the highest temperature of the blast lamp or muffle furnace for at least five minutes, cooled and weighed. To the residue in the crucible one or two drops of strong sulphuric and 5 cc of hydrofluoric acids are added, and the solution is evaporated to the expulsion of sulphuric acid. The residue is ignited as before and again weighed; the difference between the two weights is silica.

Silica.

USING 1 TO 5 GRAMS WHEN ALL OR PART OF THE FILTRATE IS USED FOR THE PHOSPHORUS OF OTHER DETERMINATIONS.

One to 5 grams of the sample are transferred to a dish (beaker optional) with a watch-glass cover, 20 to 50 cc of strong hydrochloric acid are added, and a gentle heat is applied, without boiling, for about one-half hour. The solution is diluted with an equal volume of water, filtered into another dish of the same size, and the visible iron stain is washed out of the filter paper. This solution, containing the bulk of the iron, is allowed to go to dryness on the steam bath. The residue is ignited in a platinum crucible, and then fused with about six times its weight of sodium carbonate. The fusion may be leached out of the crucible, but it is found more expeditious to let it cool around the end of a platinum rod, and on again heating the crucible the entire mass adhering to the rod is removed. It is then dissolved in the original filtrate, or placed while still hot in the covered dish, in which the original solution was made and to which about 25 cc of hot water have previously been added. The small amount remaining in the crucible is dissolved in hot water, and finally in hot dilute hydrochloric acid (1 part acid to 1 part water), and added to the dish containing the fusion, which by this time has been disintegrated by the hot water and acidified with hydrochloric acid; this dish is then placed with the other on the steam bath. When the contents of both dishes are dry, 10 to 15 cc of strong hydrochloric acid are added to the dish containing the residue of the original filtrate. After heating until the ferric salt is dissolved, the solution is evaporated until the excess of hydrochloric acid is expelled, as is indicated by the first appearance of insoluble ferric chloride on the bottom or sides of the dish. Seven cc of strong nitric acid are added and heat is applied for about one minute, or until the violent reaction is over. The solution is diluted with cold water and filtered into a suitable flask. This is the procedure if all the filtrate is to be used for the phosphorus determination; but the evaporation of the excess hydrochloric acid and the addition of the nitric acid are dispensed with if the united filtrates are to be received in a volumetric flask and aliquot portions taken for the other determinations.

To the dish containing the fusion, and which should not be heated above 120° C., just enough dilute hydrochloric acid is added to moisten the residue. Hot water is then added and heat applied until all the salts are dissolved, when the solution is filtered into the same flask with the last filtrate; the combined filtrates should not exceed 150 cc if the solution is to be used for the phosphorus determination. In this case, the complete washing of the silica is continued in another flask until free from chlorides, and these washings are discarded. The filter and its contents are then ignited and weighed as silica. The filtrate in the flask is reserved for the phosphorus determination, or if in a volumetric flask, for the determinations which follow.

Phosphorus.

BY THE FUSION METHOD.

For this determination five grams of the sample are taken

*NOTE.—This clause is introduced on the insistence of the mine chemists that with certain ores evaporation to dryness is not necessary to obtain all the silica.

for all ores when the phosphorus contents are under 0.100 per cent, two and one-half grams when the phosphorus contents are between 0.100 and 0.200 per cent, and one gram when the phosphorus exceeds 0.200 per cent.

An aliquot part of the filtrate, the volume of which should not exceed 150 cc, representing one gram, or two and a half grams of the sample, from the five gram portion for silica in the volumetric flask, is boiled in a suitable flask for a few minutes with the addition of 10 cc of strong nitric acid. To this solution, or to the entire filtrate in the flask from the five gram portion, a slight excess of strong ammonia is added over the amount necessary to precipitate the iron and alumina, and after mixing enough strong nitric acid to dissolve the precipitate with from 5 to 10 cc in excess.

The solution is heated to a temperature of 80° C., 50 cc of the solution of ammonia molybdate are added, and the flask is shaken continuously for five minutes. The solution is allowed to stand until the precipitate has subsided. If the yellow precipitate is to be weighed, it is caught on a 9 cm. filter paper that has been dried for at least half an hour at 110° to 120° C. and weighed between watch glasses, washed thoroughly with a 2 per cent solution of nitric acid, dried for one hour at the above temperature and weighed between glasses; 1.63 per cent of its weight is phosphorus.

If the yellow precipitate is to be titrated by the acid alkali method, the weighing of the filter is dispensed with, the washing with the 2 per cent nitric acid is continued as before to the complete removal of the iron and molybdenum salts, and then with a 1 per cent solution of potassium nitrate until free from acid. The filter and its contents are then transferred to a small flask or beaker and an excess of the standard alkali added. When the precipitate is all dissolved by shaking or stirring, about 150 cc of water and a couple of drops of a saturated solution of phenolphthalein in alcohol are added, and the solution is back titrated with the standard nitric acid to the disappearance of the color. It is optional to again add the standard alkali, the end point being a faint, permanent, pink color.

The yellow precipitate may also be dissolved in dilute ammonia, and the phosphorus determined by the permanganate titration method as subsequently described. Or it may be dissolved in a hot ammoniacal citrate solution and the phosphorus precipitated as ammonium magnesium phosphate, as hereafter described.

Ammonium Molybdate Solution: This solution is made in the following proportions. To 225 grams of pure molybdic acid in a suitable flask there is added 500 cc of water, and then 500 cc of strong ammonia. When in solution, this is poured into a flask containing 2500 cc of nitric acid of 1.20 sp. gr., the solution being kept agitated, and three or four drops of ammonium or sodium phosphate solution are added to coagulate the suspended impurities. The solution is kept in a warm place over night or until the supernatant liquid is clear, when it is filtered into a bottle for use.

Stock Solution of Caustic Soda: 145 grams are dissolved in water and the solution is diluted to 2200 cc; 200 cc of this solution diluted to 2000 cc will be of approximate strength.

Nitric Acid: 20 cc of strong nitric acid are diluted to 2000 cc. These solutions are made exactly agreeing, and standardized on steels or ores of known phosphorus contents so that each cc used corresponds to 0.01 per cent phosphorus, when two grams of the sample are used. This weight has been found the most convenient for steel analysis, and a simple calculation enables it to be used for varying weights of either steel or ore.

Phosphorus.

DIRECT DETERMINATION OF THE SOLUBLE PHOSPHORUS USING THE PERMANGANATE OR THE ACID ALKALI TITRATION.

This method is particularly applicable to ores wherein all or a fairly constant proportion of the phosphorus is soluble in strong acid. The insoluble phosphorus is determined at less frequent intervals, and the amount so obtained added to the soluble gives the total phosphorus.

From one to five grams of the sample, according to the phosphorus content, are placed in a beaker with a watch-glass cover, 20 to 50 cc of strong hydrochloric acid are added and a gentle heat is applied until the ore is dissolved. Two or three drops of nitric acid are added and the solution is boiled a minute or two, and then the excess acid evaporated. The solution is diluted and filtered, the filtrate being received in an 8 to 16 ounce Erlenmeyer flask; the filter and residue are washed with dilute hydrochloric acid (1 part acid to 4 parts water) and water until free from iron discoloration.

Strong ammonia is now added until a slight precipitate persists, or until the iron is completely precipitated, and in either case this is dissolved with strong nitric acid, too great an excess being avoided. The solution is heated to 80° C., 30 to 50 cc of ammonium molybdate solution are added, the flask is shaken and placed in a warm place to allow the precipitate to subside. The greater part of the supernatant liquid is siphoned off, the remainder being filtered, or the entire solution is filtered. The precipitate is washed with ammonium sulphate solution or a 2 per cent sulphuric acid solution, until free from iron and molybdenum salts.

The funnel containing the precipitate is transferred to the flask in which the precipitation was made, and the precipitate dissolved in dilute ammonia (1 part ammonia to 3 parts water); the resulting solution should not exceed 25 cc. Eight grams of granulated zinc (20 mesh) are added, then 75 cc of sulphuric acid (1 part acid to 4 parts water), and the solution is boiled gently until reduction is complete. It is then filtered through glass wool or cotton, the filtrate being received in a beaker, and the flask and filter are washed thoroughly with cold water. The solution is titrated with potassium permanganate until a slight, permanent, pink tint is obtained. From the number of cc used, the percentage of phosphorus is calculated.

If the acid alkali titration is to be used, the yellow precipitate is washed as before with a 2 per cent nitric acid solution until free from iron and molybdenum salts, then with a 1 per cent solution of potassium nitrate until free from acid, and the determination is completed in the regular manner.

SOLUTIONS.

STANDARD PERMANGANATE.

204.5 grams potassium permanganate,
1 carboy (48 liters) distilled water.

AMMONIUM MOLYBDATE.

300 grams molybdic acid dissolved in
1200 cc ammonium hydrate, sp. gr. 0.96. This is to be added slowly to
4500 cc nitric acid, sp. gr. 1.20, keeping the solution agitated.

AMMONIUM SULPHATE.

40000 cc distilled water,
1100 cc ammonium hydrate, sp. gr. 0.96,
960 cc sulphuric acid, sp. gr. 1.84.

PHENOLPHTHALEIN.

Saturated solution in alcohol.

Phosphorus.

BY IGNITION OF THE INSOLUBLE RESIDUE.

One to five grams of the sample in a porcelain dish, with watch-glass cover, are digested in 20 to 50 cc of strong hydrochloric acid with the aid of a gentle heat. After diluting slightly with cold water, the solution is filtered into another dish of the same size and the precipitate washed free of the visible iron discoloration. The filtrate is rapidly evaporated and while this is in progress, the residue is transferred to a platinum crucible and ignited in a muffle furnace or over a blast lamp. The residue is broken up, reignited for a few minutes, then transferred into the original filtrate and the solution is evaporated to dryness.

Fifteen cc of strong hydrochloric acid are now added and

the solution is evaporated until ferric chloride begins to separate in the solid state. To the covered dish 7 cc of strong nitric acid are added and heating is continued for about one minute. The solution is diluted with cold water and filtered into a suitable flask. The filter and precipitate are washed with a 2 per cent nitric acid solution until the iron discoloration is removed.

With unknown ores, and at regular intervals with all ores, as a check, the insoluble residue is fused with sodium carbonate. The fusion is dissolved in dilute hydrochloric acid (1 part acid to 1 part water), and the solution is evaporated to dryness. The residue is redissolved in dilute hydrochloric acid and the solution is filtered into the main filtrate, which has also been evaporated to dryness, and the residue treated as described in the previous paragraph after the evaporation to dryness. The filtrate, or the combined filtrates in the flask are made ammoniacal, and the precipitate is dissolved in strong nitric acid with 5 to 10 cc in excess. The solution is brought to a temperature of 80° C., 50 cc of ammonium molybdate solution are added and the flask is shaken for five minutes.

When the precipitate has subsided, it is filtered off and washed with a 2 per cent solution of nitric acid. From this point the yellow precipitate may be weighed, or titrated by the acid alkali or permanganate methods as previously described, or dissolved, reprecipitated, and weighed as magnesium pyrophosphate in the following manner:

The yellow precipitate is dissolved on the filter with hot ammonium citrate solution (175 cc strong ammonia to 325 cc water containing 25 grams citric acid), the filtrate being received in a No. 9 beaker. The filter is washed several times with hot water, then 5 to 10 cc of magnesia mixture (100 grams magnesium sulphate plus 300 grams ammonium chloride in 800 cc hot water plus 400 cc strong ammonia) are poured through the filter. The filtrate in the small beaker is thoroughly mixed and allowed to stand for at least three hours, and if possible over night. The precipiate is filtered off, washed with dilute ammonia (1 part ammonia to 4 parts water), ignited at a low temperature until the carbon of the filter is destroyed, then at the highest temperature of the muffle furnace or burner, cooled and weighed as magnesium pyrophosphate containing 27.84 per cent phosphorus.

Phosphorus.

WHEN TITANIUM IS PRESENT.

Two grams of the sample are intimately mixed with eight to ten times its weight of sodium carbonate in a large platinum crucible and fused over a blast lamp, the fusion being maintained at the highest temperature for fifteen to twenty minutes. The fusion is then transferred to a beaker containing hot water and thoroughly disintegrated; the solution is then filtered and the residue washed with hot water, or preferably with a 1 per cent solution of sodium carbonate. As an extra precaution not deemed necessary in everyday work, the residue may be ignited until the filter is destroyed, crushed in the crucible, fused, disintegrated and filtered off as before, the filtrates being combined. The filtrate, or the combined filtrates are acidified with hydrochloric acid and evaporated to dryness. The residue is moistened with dilute hydrochloric acid, dissolved in hot water and the solution filtered into a suitable flask.

The filtrate is made ammoniacal, then strong nitric acid is added with from 5 to 10 cc in excess. The solution is brought to a temperature of 80° C., 50 cc of ammonium molybdate solution are added, the flask is shaken for five minutes, and the phosphorus determined by any of the methods previously described.

When it is desired to separate the phosphorus from the large amount of sodium salts in the filtrate after the evaporation to dryness, a weighed amount of iron, about 0.05 gram, of known phosphorus content, and in the ferric condition, is added and precipitated in the hot solution with ammonia. The precipitate is filtered off, dissolved in warm, dilute nitric acid, and if the resulting filtrate is somewhat cloudy from particles of filter paper in suspension, and it is desired to remove them, it is refiltered after the addition of a little paper pulp. This filtrate is now made ammoniacal, 5 to 10 cc excess nitric acid are added, and the determination is completed as above described.

Alumina.

PHOSPHATE METHOD.

For this determination the hydrochloric acid filtrate from the silica of one gram of the sample, or the hydrochloric acid solution of the precipitated iron and alumina from the gravimetric determination of manganese is used. To the cool solution diluted to about 400 cc in a No. 5 beaker, 30 cc of a 10 per cent solution of ammonium phosphate are added, and then ammonia until a faint, permanent precipitate is formed. One and one-half cc of strong hydrochloric acid are now added, the solution is stirred until the precipitate is dissolved, and 50 cc of a 20 per cent solution of sodium hyposulphite are added. The solution is heated just to the boiling point, at which 8 cc of strong aceitc acid and 15 cc of a 20 per cent solution of ammonium acetate in the same measure are added, and the boiling is continued ten minutes. The precipitate is allowed a few minutes to subside, is filtered off as quickly as possible and washed ten times with hot water. The filter and its contents are ignited at a low temperature until the carbon is destroyed, then at the highest temperature of the muffle furnace, cooled and weighed as aluminium phosphate, 41.85 per cent of which is alumina.

Alumina.

ETHER METHOD.

One to five grams of the sample are placed in an 8-ounce beaker and dissolved in 20 to 50 cc of strong hydrochloric acid with the aid of a gentle heat. The solution is diluted and filtered, the residue washed, and the filtrate evaporated to dryness. The residue on the filter is ignited in a platinum crucible, 2 to 6 drops of sulphuric (1 part acid to 1 part water) and 5 to 10 cc of hydrofluoric acids are added and the solution is evaporated to dryness. The residue in the crucible is fused with one-half to two and one-half grams of potassium or sodium bisulphate and dissolved in 10 cc of dilute hydrochloric acid (1 part acid to 1 part water). The residue from the original filtrate, after its evaporation to dryness, is dissolved in 20 to 30 cc of hydrochloric acid, 1.13 sp. gr., cooled and transferred to a separatory funnel, 40 to 100 cc of ether are added, and the funnel is shaken for one minute, the solution being kept cool. The acid layer is drawn off into an 8-ounce beaker, and to this is added the solution obtained from the treatment of the insoluble residue. The combined solutions are heated until the ether is driven off, a few crystals of sodium or potassium chlorate are added, and the heating is continued until free chlorine is expelled. The solution is diluted to about 75 cc, ammonia is added until a slight precipitate persists, then 10 cc of a 20 per cent solution of ammonium acetate. The solution is boiled about one minute and filtered; the precipitate is washed with hot water, then dissolved in warm dilute hydrochloric acid. After being diluted to about 75 cc and a slight excess of ammonia added, the solution is boiled, filtered and the precipitate washed as before. The combined filtrates are reserved for the determination of manganese, lime and magnesia. From this point the alumina may be determined by either of the following methods:

The precipitate is ignited, and weighed as oxides of iron, alumina and phosphorus. The ignited oxides are dissolved in 3 cc of stannous chloride and 10 cc of strong hydrochloric acid, and the iron is titrated with a weak bichromate solution, 1 cc of which is equal to 2 per cent iron. Or the precipitate is fused with sodium carbonate, the fusion is dissolved in hydrochloric acid and the iron titrated as above. The iron calculated as the sesquioxide, plus the phosphorus as pentoxide is

deducted from the total weight of the precipitate leaving the alumina.

Or the filter and precipitate are ignited at a low temperature until the carbon is destroyed. The precipitate is crushed in the crucible and thoroughly fused with about 5 grams of sodium carbonate. The fusion is dissolved in hot water, a little paper pulp is added to reduce any manganese that may be present, the residue is filtered off and washed. The filtrate received in a small beaker is acidified with hydrochloric acid, heated to boiling, and ammonia is added in slight excess. After boiling for a minute or two, the precipitate is filtered off, washed with hot water, ignited and weighed. This weight minus the weight of the phosphorus as pentoxide is alumina.

Manganese.

GRAVIMETRIC METHOD.

The filtrate from the one gram portion for silica, or an aliquot part of the filtrate, equal to one gram of the ore, from the five gram portion for silica in the volumetric flask, is boiled for a few minutes in a No. 5 beaker with the addition of 10 cc of strong nitric acid. A basic acetate separation is then made as follows: The solution is diluted with cold water to about 150 cc and the greater part of the free acid is neutralized with strong ammonia, then cautiously with dilute ammonia (1 part ammonia to 4 parts water) with vigorous stirring, until a faint precipitate persists. The solution is then diluted with hot water to about 400 cc, 25 cc of a 20 per cent solution of ammonium acetate are added, the solution is heated to boiling and boiled about one mintue. After the precipitate has subsided, the solution is filtered through a 185 mm filter on a 4-inch ribbed funnel into a No. 6 beaker.

When the manganese is under one per cent, only one basic acetate separation is made and the precipitate is washed several times with hot water. If over one per cent, the precipitate is washed but once, then dissolved on the filter in hot, dilute hydrochloric acid and the basic acetate separation made as before, except that the dilution before precipitating need not be so great. The filtrate and washings, or the combined filtrates in this determination, or from the iron and alumina in the ether alumina method are heated to boiling and 25 cc of strong ammonia added, and then cautiously about 1 gram of ammonium persulphate. One gram is sufficient to precipitate the manganese in any iron ore. The solution is boiled about ten minutes and the precipitate filtered off, wash with hot water, ignited at a gentle heat and then at the highest temperature of the muffle furnace or blast lamp, and weighed as mangano-manganic oxide, containing 72.05 per cent manganese. This precipitate may be dissolved before or after ignition, reprecipitated, and weighed as manganese pyrophosphate.

The ignited precipitate of mangano-manganic oxide is usually contaminated with a small amount of silica sufficient to cause an appreciable error in a small percentage of manganese. In this case it is dissolved in the crucible in warm, dilute hydrochloric acid; the residue, if any, is filtered off, washed, burned and the weight obtained is deducted from the previous weight.

The precipitate of iron and alumina on the filter obtained in this determination is to be retained for the determination of alumina by the phosphate mtehod.

Manganese.

VOLHARD'S METHOD.

One to two grams of the sample are placed in a No. 2 beaker with cover, 15 to 25 cc of strong hydrochloric acid are added, and heat is applied until the ore is dissolved. Five cc of nitric acid or a few crystals of potassium chlorate are now added, and the solution is boiled until nitrous fumes or free chlorine are expelled. Evaporation is continued to the expulsion of free acid, the solution is diluted to about 100 cc and washed into a volumetric flask. Zinc oxide emulsion is added in excess, the solution is diluted to the mark and mixed thoroughly; the precipitate is allowed to subside and an aliquot portion is decanted off, equal to one-half or one gram of the ore. For ores low in manganese the solution is made slightly turbid with zinc oxide emulsion to coagulate the manganese dioxide set free in the titration. The solution is heated to boiling and titrated with permanganate until a faint, pink color persists. Or, after the dilution to about 100 cc, the solution is washed into a half-liter flask, an excess of zinc oxide emulsion is added as before, the solution is heated to boiling and titrated directly in the presence of the iron precipitate.

Strength of permanganate solution for iron ores: 1 cc equals 0.1 per cent manganese, standardized on iron ore of about ½ per cent manganese content.

For manganese ores the procedure is the same up to the removal of the free acid and the addition of zinc oxide emulsion, when the solution is diluted to the mark in a 500 cc volumetric flask and mixed. Then 50 cc are transferred to a flask, diluted to about 250 cc, heated to boiling and titrated as before. No zinc oxide emulsion need be added here, the voluminous precipitate of manganese dioxide acting as coagulent.

Strength of permanganate solution for manganese ores: 1 cc equals 0.3 per cent manganese, standardized on manganese ore of known manganese content.

Manganese.

COLOR COMPARISON OR TITRATION METHOD.

One gram of the sample in a porcelain dish, or beaker, is warmed after the addition of 25 cc of strong hydrochloric and 5 cc of strong sulphuric acids, and when in solution the heating is continued until fumes of sulphuric acid appear. The solution is allowed to cool, 25 cc of water are added, heat is applied until the salts are dissolved, and the solution is transferred to a 50 cc volumetric flask, diluted to the mark and mixed. If the color comparison method is to be used, the solution should be poured through a dry filter after mixing; if the titration method is to be used, the filtration may be omitted. With a pipette 10 cc, equal to 0.2 gram of the ore, are transferred into a 1-inch by 8-inch test tube, if for comparison, or into a 150 cc Erlenmeyer flask, if to be titrated. Fifteen cc of the nitrate of silver solution are added, the solution is heated over a flame or in a water bath, and about one gram of ammonium persulphate is added. The reaction takes place equally well in a nitric or sulphuric acid solution or a mixture of the two. The essential point is the presence of a sufficient amount of silver nitrate. As soon as the formation of the permanganic acid is well under way, the test tube or flask is removed from the source of heat and placed in a cold water bath. This solution may be compared against the color obtained from an ore or a steel of known manganese content, in the latter case by dissolving 0.2 gram of the steel in 10 cc of nitric acid of 1.20 sp. gr., adding 15 cc of the silver nitrate solution and the persulphate as above.

If the solution in the 150 cc Erlenmeyer flask is to be titrated, it is diluted to about 100 cc, 7 cc of a 0.2 per cent solution of C. P. sodium chloride are added and the sodium arsenite solution is run in until the color is just discharged.

If the insoluble residue is suspected of containing manganese, it is filtered off, burned, 2 or 3 drops of sulphuric (1 part acid to 1 part water) and about 5 cc of hydrofluoric acids are added and the solution is evaporated until sulphuric acid fumes appear; 5 cc of the same dilute sulphuric acid are added, and the crucible is warmed till the residue is in solution, when it is added to the main solution.

The stock solution of silver nitrate is made in the proportion of 66.66 grams of the salt to the liter. Twenty cc of this solution are diluted to one liter for use; each 15 cc contains 0.02 grams of silver nitrate.

The sodium arsenite solution is made by boiling 10 grams of arsenious acid until dissolved in an equeous solution of 30 grams of sodium carbonate and diluting to 1 liter. About 125 cc of the stock solution are diluted to 2000 cc, and this solution

is standardized on steels or ores of known manganese contents so that 1 cc equals 0.1 per cent manganese on a 0.2-gram sample.

Manganese.

PEROXIDE REDUCTION METHOD.

One-half to three grams of the sample in a beaker are digested in 20 to 50 cc of strong hydrochloric acid. If the insoluble residue is suspected of containing manganese, a few drops of hydrofluoric acid are added, and the solution is evaporated almost to dryness. Manganese free glass must be used if hydrofluoric acid is employed. Seventy-five cc of strong nitric acid are added, the solution is boiled until clear, the manganese is precipitated as dioxide by the addition of a slight excess of potassium chlorate, and the boiling is continued for about five minutes. The solution is cooled, diluted to about 300 cc with cold water, and a definite amount of hydrogen peroxide solution is added from a pipette. After the reduction of the dioxide, the excess of hydrogen peroxide is determined by titration with standard potassium permanganate solution. The value of the peroxide solution in terms of permanganate is determined, and from the total volume of peroxide used, less the excess determined by the permanganate titration, the percentage of manganese is calculated.

The relative value of these two solutions is determined as follows: About 60 cc of strong nitric acid are boiled for about five minutes in a beaker, then cooled and diluted to about 300 cc. To the cold solution a definite amount of the peroxide solution is added and titrated with the standard permanganate.

The hydrogen peroxide solution is made by diluting one pound of hydrogen peroxide to 9,000 cc, containing 200 cc of strong sulphuric acid.

The permanganate solution contains 1.7375 grams per liter and is standardized against an ore of known manganese content.

Lime.

The filtrate from the persulphate or bromine precipitation of the manganese, after the basic acetate or ammonia separation of the iron and alumina, is heated to boiling in a No. 6 beaker, 10 cc of strong ammonia and 5 cc of a saturated solution of ammonium oxalate are added, and the heating is continued until the volume of the solution is reduced to about 150 cc. When the lime is low it is essential that the evaporation be continued to this point to insure complete precipitation. Five cc of strong ammonia are now added and the solution is boiled for about ten minutes. The precipitate is then filtered off, washed with hot water, burned and weighed as calcium oxide. In normal ores when the lime and magnesia are low, only the first few washings are allowed to flow into the filtrate, the object being to keep the filtrate as concentrated as possible for the magnesia determination which follows. The calcium oxide is also liable to be contaminated with a small amount of silica, and, when extreme accuracy is desired, the ignited and weighed precipitate is dissolved in warm, dilute hydrochloric acid and the solution is evaporated to dryness. The residue is dissolved in dilute hydrochloric acid, the silica is determined and deducted from the previous weight.

If the lime is to be titrated, it is dissolved on the filter in 25 cc of hot, dilute sulphuric acid (1 part acid to 4 parts water), the solution is diluted with 150 cc of hot water and titrated with permanganate of such strength that 1 cc equals about 0.100 per cent lime.

Magnesia.

The filtrate from the calcium oxalate, which should not exceed 200 cc in volume, is made slightly acid with strong hydrochloric acid, and 5 cc of a 10 per cent solution of ammonium phosphate are added, then to the cool solution 25 cc of strong ammonia, drop by drop, with continuous stirring during the addition. The solution is stirred at intervals for two or three hours, or continuously on a machine for one hour, and if permissible it is allowed to stand in a cool place over night. The precipitate is filtered off, washed thoroughly with dilute ammonia (1 part ammonia to 4 parts water), ignited at a low temperature until the filter is destroyed, and finally at the highest temperature of the muffle furnace or blast lamp, and weighed as magnesium pyrophosphate containing 36.24 per cent magnesia.

Sulphur.

FUSION METHOD.

One gram of the sample is intimately mixed in a capacious platinum crucible with about ten grams of sulphur free sodium carbonate, and not more than a half gram of potassium nitrate. The crucible is heated cautiously over a blast lamp until the fusion is quiet, the last few minutes of the fusion being at the highest temperature of the blast. If sulphur bearing gas is used, the contents of the crucible must be protetced from the flame gases with a suitable shield. The fusion is completely disintegrated in hot water, to which a few drops of alcohol may be added to reduce and precipitate any manganese present. The solution is filtered and the residue washed with hot water, or preferably with a 1 per cent solution of sodium carbonate.

To the filtrate, the volume of which is about 150 cc, there is cautiously added a slight excess of hydrochloric acid. The solution is heated to the boiling point, 5 cc of a 10 per cent solution of barium chloride are added, and the beaker is placed on the steam bath or hot plate until the precipitate has subsided. The precipitate is then filtered off, washed with hot water till free from chlorides, burned in an open crucible and weighed; 13.73 per cent of the weight is sulphur.

If the precipitate is suspected of containing silica, which is rarely the case, it can be purified after ignition by adding a drop of sulphuric and 2 or 3 cc of hydrofluoric acids, evaporating and igniting as usual.

If sulphur free sodium peroxide is used for the decomposition of the ore in place of the sodium carbonate and niter, the fusion is made in a nickel crucible with about 5 grams of the peroxide; the remainder of the treatment is the same.

Sulphur.

WET METHOD.

Five to ten grams of the sample in a porcelain dish or beaker, with a watch-glass cover, are dissolved in 50 to 100 cc of aqua regia (1 part nitric acid to 9 parts hydrochloric acid) and the solution is evaporated to dryness. The residue is dissolved in 20 to 40 cc of strong hydrochloric acid and the solution evaporated until the first appearance of insoluble ferric chloride. This is dissolved by the addition of a slight excess of strong hydrochloric acid, the solution is diluted to about 75 cc, and filtered into a suitable beaker, the residue being washed with hot water and the least possible amount of dilute hydrochloric acid.

If the insoluble residue is suspected of containing sulphur compounds insoluble in aqua regia, it is fused with the least possible amount of sodium carbonate and niter, as previously described in the Fusion Method for Sulphur. The fusion is disintegrated in hot water, the solution is filtered, acidified with hydrochloric acid and added to the main filtrate, or the sulphur may be estimated separately.

The filtrate is heated nearly to boiling, and after the addition of 5 cc of a 10 per cent solution of barium chloride it is again evaporated until a film of ferric chloride appears. This is dissolved by the addition of a few drops of strong hydrochloric acid and, with a wash bottle, a stream of cold water is forced into the solution until its volume is from 175 to 250 cc. It is then set aside in a cool place over night. The precipitate is filtered off, washed with hot water and dilute hydrochloride acid until free from iron, burned and weighed as usual.

Ignition Loss.

One gram of the sample is placed in a platinum crucible with a tightly fitting cover and ignited at a bright red heat for fifteen minutes. It is then allowed to cool in a desiccator and weighed.

This is repeated with five minutes ignition until constant weight is obtained.

Moisture.

A portion, or the entire sample reserved for the moisture determination, in either case not less than two kilograms, is transferred to a suitable pan and weighed, dried at 100° C. until constant weight is obtained and the percentage of moisture calculated.

Heat Conductivities in the Calculation of Furnaces.

By Carl Hering.

It is well known to all those who have made calculations involving heat conductivities that the necessary constants representing the conductivities or specific conductances are not always to be found in tables, and when they exist, they are not always in the form in which they are wanted. Among the latter cases is the one in which the heat conductivity is given for certain different ranges of temperature, as, for instance, from 0° to 500° C., and from 0° to 1300° C., but not for the range between the two high temperatures. This constant represents the mean value when the stated temperatures are the two given extremes.

It not infrequently happens that this mean is required for a range between the two higher temperatures instead of from 0° up. For instance, it is customary, and very good practice, to use one kind of heat insulating material for the inner lining of a furnace, choosing it for its refractory property, and a different material for the outer layer of the furnace wall, selecting it for its heat insulating property. This is due to the fact that materials which are very refractory are not always the best heat insulators. Infusorial earth, for instance, is an excellent heat insulator at the lower temperatures, but loses this property at very high temperatures; while firebrick, suitable for very high temperatures, is a good refractory material, but is not nearly as good a heat insulator for the outer portions of the furnace as infusorial earth is.

In calculating the heat losses by conduction through the walls of such furnaces, made of several materials, as, for instance, firebrick on the inside and infusorial earth on the outside, it is necessary to know what the heat conductivity is for firebrick between two high temperatures, and the figures in the tables are not generally given in that way. The purpose of the present article is to show how this may be calculated correctly from given data and without assuming any particular law of variation. The importance of calculating it instead of the more usual practice of guessing at it is shown by the rapid rise of this constant with increasing temperatures.

The calculation, is, of course, limited to the ranges given in the tables. If, for instance, the heat conductivity for firebrick is given as 0.0014 as a mean from 0° to 500°, and 0.0031 as a mean from 0° to 1300° C., it is possible to calculate correctly the corresponding figure between the two given high temperatures, 500° and 1300°. These particular values are in the c.g.s. system and mean the calories per second which will pass through 1 cm of the material, 1 sq. cm in section, for a difference of 1° C. between the two surfaces.

Let k be this heat conductivity for the lower range of temperature, t, and K the corresponding figure for the higher range T; let t' and T' be the two maximum temperatures of the ranges t and T, respectively; and let H represent the heat in calories per second passing through a body. For 1 cu. cm

$$H = kt.$$

Assume another piece of the same material, also 1 cm cross-section, and of such length L, that it will conduct the same quantity of heat, H, when its ends have the temperatures 0° and T', for which the mean conductivity is K. For this rod

$$H = \frac{KT}{L};$$

but as the heat flow H is by definition the same in both, it follows that

$$kt = \frac{KT}{L} \qquad (1)$$

In the accompanying diagram the first rod is represented by the small cube, and the second one by the long rod.

Now, let x be the quantity desired, namely, the mean conductivity between the two higher temperatures t' and T'. It will be seen from the diagrams that, as the flow of heat is the same in both, it necessarily follows that the longer rod will have a temperature of 500° at a distance of 1 cm from the cool end, because that last centimeter must be under precisely the same conditions as the cube above, in order that the flow of heat is the same. Hence, it follows that there will be a fall of temperature from T' to t' over a length of this rod equal to $L - 1$; and as the heat flowing through this portion is the same as through the whole rod, it follows that

$$H = \frac{x\,(T' - t')}{L - 1} = kt \qquad (2)$$

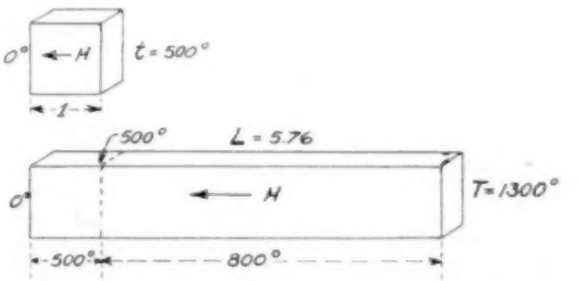
Eliminating L from equations (1) and (2) and solving for x gives the desired quantity

$$x = \frac{KT - kt}{T' - t'}$$

Applying this by illustration to the above data for firebrick, it will be found that

$$x = 0.00416,$$

which, therefore, is the mean heat conductivity of firebrick for the range 500° to 1300° C.



CALCULATION OF HEAT CONDUCTIVITY BETWEEN CERTAIN TEMPERATURES.

Incidentally, it may be of interest to solve equation (1) for L, and it will be found to be 5.76 cm. The two rods in the above diagram have been drawn to scale. The diagram, therefore, shows graphically what a very large amount of firebrick is necessary to reduce the temperature in the walls from 1300° to 500° (namely, 800°), and what a relatively small thickness is required for the remaining 500°. This, of course, is due to the fact that firebrick rapidly loses its insulating properties at high temperatures. It shows how important it is to have as thin a layer of firebrick and as thick a layer of infusorial earth as possible, the relative amounts depending upon the maximum temperature at which the high insulating material will retain its good quality.

The Use of Lime and Increased Temperatures in Cyanidation.

A recent paper of Mr. Leo D. Bishop, metallurgist with the Hendryx Cyanide Marchinery Co., of Denver, Col., presented before the Colorado Scientific Society and published in full in the *Proceedings* of this society, Vol. IX, page 99, deals in a very interesting manner with certain special features of the cyanide process, especially with the effect of alkalis in conjunction with cyanide solutions, the selection of the proper alkalinity, the choice of the lime and the necessary care in its handling and use, and finally with the effect of heat and motion on the dissolution of gold from ores.

Use of Alkalis with Cyanide Solutions.—Most all ores which are amenable to the cyanide process contain both free

and latent acids, which destroy cyanide. Consequently, a protective alkalinity must be maintained to prevent the useless consumption of cyanide. Alkalis must also be used for the purpose of hastening the filtration of solutions, especially where there is any appreciable amount of slime or finely ground ore.

For the purpose of settling slime, it is not necessary that an alkali or hydroxide be used. More effective settlement can be had by the use of distilled water than either the use of acid solution or hydroxides. Sodium hydroxide produces a coagulation of the slime and a rapid and compact settlement, but leaves a poorer clarification than lime. However, when properly slacked lime is added to the slime, a flocculent effect is obtained and the slime coagulates into a flaky curd, which does not settle out so compactly by gravity, but does leave a clearer and more brilliant solution than either sodium hydroxide or acids.

It is not necessary for the purpose of settlement that the slime be coagulated. In fact, it is oftentimes injurious for this purpose that lime be added. It is necessary, however, that lime be used and the slime coagulated for the purpose of rapid and clean filtration. In fact, it is almost an absolute condition precedent that every particle of slime be completely coagulated in order to get the most rapid filtration and a clear solution suitable for good precipitation.

Mr. Bishop has carried out some interesting experiments with a sample of ore furnished by the Creston Colorado Co. at Minas Prietas, Sonora, Mexico, which was completely oxidized and siliceous in character, containing a high percentage of slime. This ore was ground in a tube mill until it all passed a 200-mesh screen. In all cases a sample of two parts by weight of solution to one of ore was made and allowed to settle for one hour at different temperatures and with different additions of lime.

The results of these experiments are given graphically in Mr. Bishop's paper, but for the sake of brevity we have condensed them in the following table, showing the amount of lime added, the temperature at which the experiment was made and the degree of settling. The latter is given in the last column. If the last column states, for instance, 18 per cent, it means that after settling for one hour 18 per cent of clear solution was obtained. The degree of settling is, therefore, represented by the percentage of solution which has become clear.

2 solution + 1 ore.....	70° Fahr.	18 per cent clarified
2 solution + 1 ore + 0.5 lb. lime per ton	70° "	18 " " "
2 solution + 1 ore + 0.5 lb. lime per ton	90° "	24 " " "
2 solution + 1 ore + 0.5 lb. lime per ton .....120°	"	30 " " "
2 solution + 1 ore + 1.5 lb. lime per ton	70° "	10 " " "
2 solution + 1 ore + 1.5 lb. lime per ton	90° "	12 " " "
2 solution + 1 ore + 1.5 lb. lime per ton .....120°	"	18 " " "

The results show clearly that a large excess of lime hinders the settling of the slime, while an increase of temperature greatly aids settlement.

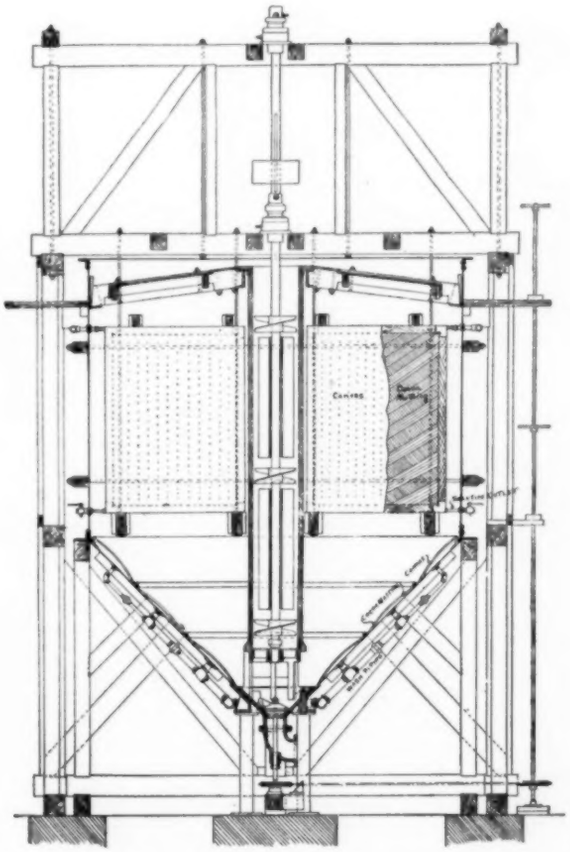
The author then made experiments to determine the effect of heat on the filtration of slime. He used a filter cell of the Hendryx type, as shown in the adjoining figure. This cell is composed of an open frame, with a canvas covering and a layer of cocoa matting between the two canvas sides. Vacuum was not used in these tests, gravity alone sufficing.

In the three tests, the excess lime was 0.50 lb. per ton of solution, and the pulp was two of solution to one of ore by weight. The amount of pulp used in each test was the same, with all conditions identical except a variation in temperature.

At a temperature of 70° Fahr. filtration of the solution was made at the rate of 8¼ lb. solution per hour per square foot of canvas. At 90° Fahr., or a raise of 20°, the rate was more than doubled, the flow of solution reaching 18 lb. per square foot of canvas per hour, and at 110° Fahr. filtration was made at the rate of 24¾ lb. per hour per square foot of canvas. In other words, with the temperature increased 40° the rate of filtration was increased just three times.

It is evident that an increase of temperature has a very pronounced effect on the filtration of slimes. A greater part of the success of some of the present filter systems is no doubt due to an increase of temperature in the mill solutions.

Proper Alkalinity, Choice and Care of Lime.—The question as to the most economical and satisfactory neutralizer must depend almost entirely on the ore which is being treated. Only by making comparative tests as to the percentage of extraction, the consumption of cyanide and the cost per ton of ore for



HENDRYX FILTER AGITATOR.

neutralization can this be determined intelligently. Moreover, the effectiveness of precipitation is also too often influenced by the character and quantity of lime used.

Some ore show an appreciable advantage in extraction by using sodium hydroxide in conjunction with lime, thereby obtaining an increased extraction and a less consumption of cyanide. A sample of ore from Black Hawk, Col., gave an extraction of 11.9 per cent with a loss of 4.10 lb. cyanide per ton using both lime and sodium hydroxide as neutralizers. Where lime alone was used the extraction was lowered to 59.7 per cent, and the consumption of cyanide increased to 6 lb. per ton of ore. In this case, the use of 1.50 lb. of sodium hydroxide per ton of ore raised the extraction 12 per cent and lowered the loss of cyanide 1.90 lb. per ton of ore.

In the choice of lime and the necessary care in its handling and use there seems to be an almost utter disregard. Rarely any thought is given the choice of lime. Many operators class all lime as good lime, and let it go at that. In one mill where a large tonnage of ore is run it was discovered that fully 33 per

cent of the consumption of cyanide was due to the impurities and cyanicides in the burned lime itself.

The cost of treating ore by the cyanide process is increased probably more by the unintelligent handling and use of lime than by any other one item. Many operators to-day allow their lime to become partially air slacked before using. After standing exposed to moisture and air, it is then fed in with the ore and drowned with an excess of cold solution.

For the purpose of illustration, the author has taken a Missouri lime, thoroughly calcined. The first sample of this lime was exposed to the air until it became partially air slacked; 0.25 lb., with 1 lb. of water, were then boiled for five minutes, after which the soluble calcium hydroxide was washed out by decantation with a large excess of cold water. The residue after drying amounted to 12.5 per cent.

Another sample of 0.25 lb. of the same partially air-slacked lime, with 10 lb. of water at 65° Fahr., was allowed to stand for three days with occasional stirring. The soluble calcium hydroxide was then washed out with an excess of cold water. After drying, the residue amounted to 35 per cent of the original amount.

The conclusion arrived at from these two tests shows that fully 35 per cent of the weight of the lime is lost by allowing it to become partially air slacked and then to attempt to slack the remainder by means of a large excess of cold water.

For the purpose of comparison the next tests were made on lump lime ground to pass a 1/3-in. mesh screen. In the first case 0.25 lb. of lime was placed in 20 lb. of water at 65° Fahr., and allowed to stand for three days, with occasional stirring. The soluble hydrate was then removed with an excess of cold water and the residue dried; 25 per cent of the whole amount remained.

In the second case 0.25 lb. of crushed lump lime was mixed with 1 lb. of water. In four minutes the whole mass had reached the boiling point, due to chemical action, and had become almost thoroughly converted from the oxide to the hydrate. There were no lumps or grains left unslacked. The chemical action was practically complete, and a rich, thick paste was the result.

Settlement and filtration tests were then made on the lime water taken from the partially air-slacked lime, the cold-water-slacked and the hot-water-slacked. The pulp in each case was three of solution to one of ore, and the temperature was 70° Fahr. The partially air-slacked lime caused the slime to settle 115 cc in a 500-cc cylinder, or 23 per cent in one-half hour. The same solution filtered at the rate of 22 lb. per square foot of canvas per hour in a Hendryx filter by means of gravity.

The cold-water-slacked lime produced a settlement of the slime of 190 cc in a 500-cc cylinder, or 38 per cent in one-half hour and a filtration of 23.3 lb. solution per square foot of canvas per hour in a Hendryx filter by means of gravity.

The hot-water-slacked lime caused the slime to settle 215 cc in a 500-cc cylinder, or 43 per cent of the whole volume, in one-half hour and produced a filtration of 23.75 lb. solution per square foot of canvas per hour. The properly treated lime causes the solids to settle almost double the amount that the air-slacked does and also filters somewhat faster.

From the foregoing results the question of the proper coagulation of the slime by means of calcium hydroxide is a very important one when one comes to either the settlement or filtration of ores. Moreover, the application of heat is beyond a doubt economical and beneficial.

Effect of Heat and Motion on the Solution of Gold.—The final part of Mr. Bishop's paper deals with the dissolution of gold from ores as effected by heat and motion. Quite a complete line of experiments was carried out by T. H. Plunkett, of Toronto, Canada, on the rate of dissolutions of particles of gold ranging from 70 mgs to 800 mgs in weight, by means of percolation, agitation, and agitation and heat. A particle of gold weighing 70 mgs was dissolved completely in 72 hours by percolation. A same sized particle was dissolved in 16 hours by agitation and another of similar size in 10 hours by means of agitation and heat. However, these sized particles of gold would not reach the cyanide tanks in practice, but would be caught by amalgamation at the start.

It has been a common belief among cyanide men that the richer the ore, the longer the time of treatment necessary. Perhaps this is true in the usual methods of percolation. By means of complete and thorough agitation it is not necessarily true.

A sample of ore was furnished by Dr. D. H. Dougan, of Denver, consisting in character of white quartz with the gold physical free, assaying $2,500 gold per ton. This ore was pulverized to 200 mesh and the coarse gold removed by amalgamation. The tailings after amalgamation assayed $725.00. With an excess of cyanide strength of 0.75 per ton of solution and constant and thorough agitation for a period of only nine hours the tailings were reduced to $1.60 per ton. These results are not difficult to explain when we consider the fact that all the particles of gold remaining after amalgamation were exceedingly small and not any larger than if the ore had assayed only $25 instead of $725 per ton. The cyanide solution was dissolving each and every particle of fine gold during the period of nine hours.

Another advantage of quick treatment is clearly shown in a test made on some 20-mesh tailings furnished by Mr. W. O. McFarlane, of Denver, from the Ajax mine in New Mexico. These tailings contained a small percentage of iron sulphides. When this ore went into the leaching tanks it assayed approximately $28 gold per ton. After six weeks percolation only $1 per ton of ore was recovered. A sample of tailings from the top of the tanks was taken which went $18.40 per ton.

Without regrinding, this sample was agitated in a Hendryx agitator for a period of eight hours. The tailings then went $9.60, representing a saving of 47.8 per cent of the value of the tailings after six weeks leaching. Another sample was then reground to 150-mesh and yielded readily 93.4 per cent in four hours' agitation.

The fact that the gold had not been recovered by percolation was accounted for by several different reasons, until an examination and an assay of each foot of tailings in the leaching tanks has been made. It was then discovered that the gold has re-precipitated. The assays showed an increase of value ranging from the top of the tank to the bottom.

Moreover, quick treatment by means of agitation effects a considerable saving in cyanide consumption, especially where there is a considerable amount of sulphides. A lot of ore furnished by the Star of the East Gold Mining Co., consisting chiefly of iron sulphides, gave an almost complete extraction at 100 mesh in six hours by means of agitation and heat (90° Fahr.), with a loss of 1.35 lb. cyanide per ton of ore. This same ore yields a somewhat less extraction in six days' percolation with a consumption of cyanide ranging from 0.50 to 0.75 for each succeeding day after the first. The continual decomposition of the sulphides will, and does, produce a loss of chemicals varying with the time of treatment.

In the discussion which followed the paper, Mr. Comstock suggested that the increased rapidity of settling at higher temperatures may be explained by the decrease in viscosity of the water with increase of temperature. This is apparently confirmed by the fact that the observed volumes of clear solution in Mr. Bishop's experiments are nearly inversely as the coefficients of viscosity at the temperatures of the observations.

Nitric Acid from Air.

A paper by W. Cramp and B. Hoyle was presented in December before the British Institution of Electrical Engineers on "The Electric Discharge and Production of Nitric Acid." The authors briefly review the apparatus used by previous investigators, all of which have been mentioned before in this journal; they then describe experiments of their own.

Their apparatus is shown in Fig. 1. It consists of a high-tension transformer excited by means of an alternator and used

to feed on its high-tension side a pair of phosphor-bronze ribbon electrodes shaped almost like the well-known horn lightning arresters.

The nozzle *A* is supplied with air from an air pump and receiver, so that the air has time to cool after being compressed before issuing from the nozzle. The alternator used by them is a "Cramp self-excited" machine with a drooping characteristic and a frequency of 160. The transformer has a ratio of transformation of 100 to 1.

In the left-hand diagram of Fig. 1 *A* is the "Laval"-shaped glass nozzle, *B* the electrodes, *T* the transformer (ratio 100 to 1), *E S V* an electrostatic voltmeter on the high-tension side, *A* and *V* low-tension ammeter and voltmeter, *G* the air-pressure gauge, *O* the air outlet, *P* the air pump, *R* the air receiver, *F R* the field rheostats, *FF* the exciter and alternator field coils, *E* the exciter and *S* the stator of the alternator.

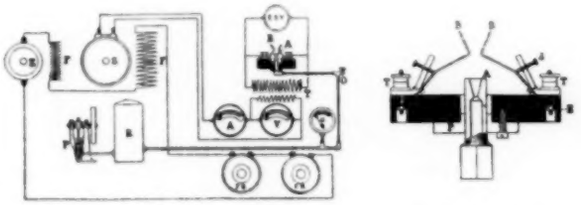


FIG. 1.—APPARATUS FOR FIXATION OF ATMOSPHERIC NITROGEN.

The details of the sparking electrodes are shown in the right-hand diagram, in which *A* is again the aluminium Laval nozzle, *B* are phosphor-bronze sparking ribbons, *P* an aluminium plate, carrying the ebonite base *E* and adjustable on *A*, while *T* are the terminals and *S* the screw adjustment for gap length.

The chief value of the paper appears to rest in the general consideration of the various forms which electric discharges assume, and which are classified as follows: glow, brush, spark, nitrogen flame (high-tension), and arc (low-tension).

By gradual increase of the current supplied to the low-tension side of a transformer, a spark between points on the high-tension side can be caused to pass through every form successively in the order: glow, brush, oscillatory spark, nitrogen flame, and flaming arc.

A curve for a discharge regulated in this way is shown in Fig. 2, where with gradual increase of pressure across a pair of points, a glow is formed in the region from *A* to *B*. At *B* a brush discharge is set up, which gradually passes between *B* and *C* into the oscillatory discharge or spark.

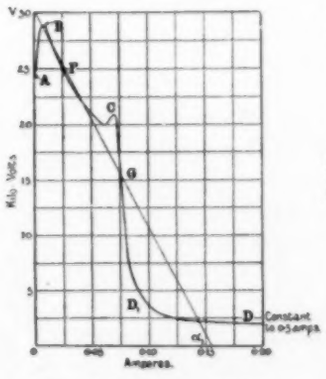


FIG. 2.—CURVES FROM PRIMARY SIDE OF TRANSFORMER.

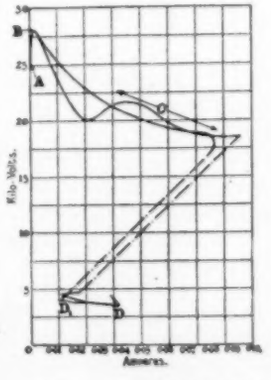


FIG. 3.—CURVES FROM SECONDARY SIDE OF TRANSFORMER.

At *C* the latter breaks down into the high-tension arc or nitrogen flame, which continues to exist with great fall of pressure to the point *D*, after which the discharge is of the character of the ordinary low-tension arc.

These characteristics and curves are correct so long as measurements are made on the low-tension side of the transformer, but if the readings of pressure and current be taken on the high-tension side, it is found that the transformer itself has considerable influence on the form of discharge.

In order to test this, readings were taken with a 30-kw, 100,000-volt, core-type transformer. One series of results obtained is plotted in Fig. 3, where the letters used agree with those in Fig. 2. The great difference between Figs. 2 and 3 lies in the fact that the line *B C* is so much longer and so much more horizontal, and that *C D* has a negative slope in Fig. 3.

An elaborate study of this and other experiments has led the authors to the following conclusions: (1) That each particular form of discharge is distinct from the others in having a different ratio of increase of potential *V* to the simultaneous increase of current *A*. (2) The glow discharge is the only one that, throughout its range, shows no negative ratio. (3) All the other forms have first a negative ratio, and then, usually, a positive ratio, as the current is steadily increased. (4) The form of discharge with the biggest negative ratio is the third form, the high-tension arc or nitrogen flame.

The authors, therefore, propose the following definitions: The silent discharge, or glow, shall mean the first discharge taking place between the electrodes in air, whose characteristic ratio[1] is all positive. The brush discharge shall mean that discharge taking place with a hissing noise accompanied by light purple-colored streamers projecting from the electrodes, but not joining them. In this form of discharge the characteristic ratio is nearly all negative. The spark discharge shall mean that discharge which succeeds the brush discharge, and whose characteristic ratio is first negative (advanced brush discharge) and then usually positive. The high-tension discharge, or nitrogen flame, shall mean that discharge which, as the pressure is further increased, follows the sparking discharge, and whose characteristic ratio is first negative and then positive. The low-tension arc shall mean that discharge which exists when the current is carried by the vapor of the electrodes and the spectrum is predominantly that of the material of the electrodes. Its characteristic is first negative and then positive.

The chemical characteristics of the five forms are fairly clearly marked. The glow and the brush discharges produce mainly ozone. The disruptive or spark discharge also produces a large proportion of ozone with a sensible proportion of oxides of nitrogen.

The arcing flame is made up of arc-threads carried into this shape by the action of the heated air to which it gives rise. It has a temperature far greater than the above, and is composed mainly of burning nitrogen, as is evident from the fact that a bottle inverted over the flame collects the well-known brown fumes of NO_2. There is no smell of ozone with this discharge.

The well-known low-tension alternating-current arc differs from it in the fact that the conducting part is mainly composed of the vapors of the material of which the terminals are composed.

The effects both of a current of air blowing on the discharge or of a magnetic field across it are the same effect so far as the form of discharge is concerned, for they tend to cause any small arc set up to travel rapidly at right angles to the field or along the line of the air stream. Consequently, the instant an arc is formed it travels away from the point of formation, under the influence of the air stream or the field, getting longer as it proceeds, and probably smaller in cross-section. This continues until it becomes of a length such as the terminal pressure will no longer support, when it is suddenly extinguished and another starts from the points.

Across the points themselves with this form of discharge, there always exists the blue line of the oscillating spark, which continually renews the arc-thread. The effect of the traveling of the threads is to increase the mean length of the discharge

[1]Meaning always the differential quotient of the voltage *V* with respect to the current *A* or the ratio of the increase of *V* to the simultaneous increase of *A*.

so that the pressure across it likewise rises for a given current. To maintain such a discharge does not necessitate anything like the same amount of external resistance or reactance as in the case with a discharge of similar type without the air current.

The effect of an increase in the capacity of the circuit was found to be somewhat similar to an increase in the blast pressure and tended to increase the oscillatory current flowing across the air-gap, and to make the discharge yield ozone if it was already being given off.

A long series of experiments was made with a view to determining the effects on the chemical results of the use of nozzles of different diameter, of change of current, of change of air velocity, of alteration of spark-gap length, and of change of capacity of the circuit.

The comparison of these variables was carried out as follows: One variable having been decided upon, everything else in the circuit was kept constant. The air which passed through the discharge had a free exit, and a known portion of it was drawn off at a known rate by means of an aspirator through a flask containing a weak solution of caustic soda of a known strength. This solution contained a little phenol-phthalene as a color indicator. As the gas was bubbled slowly through the flask the absorption of the oxides of nitrogen caused the indicator to lose its color. The time taken for the color to disappear completely was taken as a measure of the amount of acid produced in that time.

Regarding the size of the jet, it was found that the greater the amount of air passed by the jet for a given pressure, the greater is the maximum acid output, and the greater the amount of air passed by any given jet, the less is the maximum acid concentration. From this it follows that with increased quantity of air the amount of acid produced increases faster than the concentration diminishes, and therefore for a large yield per kilowatt-year with such an apparatus, a nozzle giving low concentration will probably be necessary.

Experiments with variations of current, air-gap length, and quantity of air passed indicated that increase of current gives an increased yield up to a certain maximum for each length of gap, and that the greater the quantity of air passed through the gap the higher is this maximum for each gap. In the course of these experiments the influence of the capacity of the electrostatic voltmeter on the secondary side was incidentally shown to be very marked.

The effect of frequency was much complicated by the presence of sharp peaks on some of the curves due to resonance effects. In this connection it was noticed that the higher the blast pressure, the more pronounced is resonance at certain currents, and that the higher the blast pressure, the higher is the value of the current at which oscillations are set up, and the more prominent they are.

The authors, while unable to give definite conclusions as to the effect of variations of frequency, think that it must also be allowed that the presence of a high frequency, in so far as it admits of large capacity currents across the arc and probable production of ozone, is to be considered on the whole as likely to increase the yield of peroxide. Consequently, they conclude that Kowalski and Moscicki are probably right in their statement, but that the reason for the increase in the output is not to be found in the actual increase of frequency, but rather in the increase of ozone due to this frequency, as shown below.

On the appearance of the discharge the effect of the voltmeter capacity, already alluded to, is very marked. It causes the blue oscillatory discharge, which always exists across the points, to be much enlarged in thickness and brilliancy, though the area of the nitrogen flame is hardly increased. This would agree with the theory that part of the peroxide is due to the splitting up of ozone. Photographs of the discharge were shown which estimated the effect of adding the voltmeter very clearly. Since the ozone given off in the lower portion of the discharge is more active than ordinary oxygen, it is reasonable to suppose that more nitrogen will combine than before to form nitrous products.

Further confirmation of this view was obtained from a spectroscopic examination of the discharge, and a glass tube of small diameter was inserted into the high-frequency oscillatory portion of the discharge. Gas was then drawn off and tested, and was found to be rich in ozone. By suitably placing the tube in the discharge, air mixed with ozone could be obtained, while higher up in the same discharge air mixed with nitrogen oxides was obtained.

Some experiments were also tried with reference to the ionization of the gases after formation. In the first place, it was found that the output could be sensibly improved by sudden cooling of the gases after leaving the apparatus, and a Tesla coil was connected to metal plates, between which the gases had to pass on their way to the testing apparatus, which showed that an increased output may be expected of from 5 to 20 per cent, depending upon the conditions existing. The authors' explanation was that when ionized molecules of oxygen and nitrogen pass through an electrostatic field, some of the uncombined elements may be forced together with such a velocity that chemical combination takes place between them. In this way an additional amount of peroxide is formed.

In the concluding portion of the paper the authors endeavor to show that the whole of the electrochemical phenomena discussed may be explained on "recognized ionization and electrochemical hypotheses."

As regards practical deductions, attention is called to the great importance of adapting gap, current and air blast to one another; for it is evident that changes of yield to the extent of 50 per cent or more may be obtained by slight variations of either factor from the best obtainable.

Again, it may be noticed that as regards quantity of air forced through the flame the maximum acid yield does not for a given current occur at the same point as the maximum acid strength; consequently there is a reason to doubt the value of using a magnetic field (as does Birkeland) to spread out the flame. It would appear from rough estimations made on the Birkeland-Eyde process as if the efficiency of this system was such as to lead to the belief that a very good proportion of the maximum possible yield was being obtained.

This is a most important point, for if this be true then it is hardly possible to compete with the cyanamide process in point of view of cost. If, on the other hand, by making use of the most favorable velocity, the most favorable gap-length, the introduction of ozone, the instantaneous cooling of whatever gas is produced, and fixing by subsequent ionization, much better yields may be expected, then it is well worth while proceeding on these lines in a large plant with the object of rendering the production of NO more economical.

The United States Patent System Before the American Chemical Society.

The meeting of the New York Section of the American Chemical Society, on Jan. 8, was of unusual and particularly broad interest, as the general subject of discussion was "The United States Patent System, Its Use and Abuse." The chairman of the New York Section, Dr. Leo H. Baekeland, presided.

The introductory paper was presented by Mr. F. I. Allen, late United States Commissioner of Patents, who gave a historical and descriptive sketch of the early development of the patent system, and discussed the psychology of the inventor, comparing him with a poet.

Mr. W. Hastings Swenarton, of the New York bar, late of the Examining Corps of the United States Patent Office, discussed, "patents, trade secrets and trade names as factors in industrial development—their relative functions."

The general conception of our laws relating to patents is that of statutes of monopolies. But a patent is not a true monopoly.

The United States patent system comprehensively protects in

ventions which are disclosed, through its letters patent, and to a lesser degree through its caveats. Similarly, its certificates of registration more adequately secure trade marks to their respective owners or proprietors. Trade marks, as well as trade secrets, in addition to the protection afforded by the United States patent system, have long been recognized under the common law as property rights.

While both trade secrets and trade marks are of ancient origin, the legal recognition and protection, under the common law, of trade marks, long preceded that of trade secrets. In fact, it is virtually but a century since the courts have extended their protecting arm to cover the property rights known as trade secrets.

The trade mark is a development of the ancient shop sign. The psychological effect of a trade mark may be immense, as is exemplified by the name "Uneeda."

A trade secret may comprise a process which produces an old product that is producible by other known methods in so nearly an identical condition as to prevent the determination of the method of production, even when the product is subjected to the most careful scrutiny. A typical example of the type of process which one must perforce protect as a trade secret, or else dedicate to the public by virtue of the fact that it is not susceptible of patent protection, is the electrolytic process of treating tin scrap.

No secret can be considered as coming under the protection of the common law unless it is really treated as a secret as such, and unless all parties who are cognizant of it, know that it is secret. It need not, so far as the present status of the law on this subject is concerned, be either new or sufficiently novel to be patentable.

It is often a nice question for a manufacturer to determine whether to protect his invention as a trade secret or to procure a patent thereon. The mere fact that a second inventor may at any time enter the field and apply for, and secure the grant of, a patent is a matter of serious import and worthy of the most careful consideration. This has occurred often in the past, and for this reason, it is in some cases advisable to file a caveat in the confidential archives of the Patent Office, renewing it from year to year as its term expires.

Of course, the caveat should contain as full and complete a description as any patent specification, if one would insure himself against the grant of a patent to a subsequent applicant, and since most trade secrets are carefully guarded in some secret archives, commonly of a corporation, it is obvious that no rights are sacrificed by the filing of a caveat as aforementioned.

Patents and trade marks have a considerable moral effect on the public in general and on competitors in particular. This is even true for "paper patents" and "paper trade-marks."

* * *

Mr. LOUIS C. RAEGENER, of the New York bar, spoke in a very forcible and interesting manner on "some defects in the practice of our patent system, and suggested remedies."

Having been a successful lawyer in patent cases (in many of the most important ones in the past decades), he said he was now taking "a position somewhat similar to that of the illustrious Andrew Carnegie. After the tariff had given him personally all the protection he required, he came before the world and proved that protection for him at least was no longer necessary."

In Mr. Raegener's opinion the practice and procedure of trying a patent case is antiquated, time-consuming, abnormally expensive and generally unsatisfactory; final judgments are practically unobtainable, and pecuniary judgments so rare that any well-advised infringer need hardly fear them.

To get the testimony in a patent suit ready for the court takes from a year to 18 months. Testimony is taken at a lawyer's office, usually on the typewriter. If taken stenographically, the stenographer benefits more by that method than the lawyers, because the lawyers and experts, as a rule, charge per diem, and, of course, the longer it takes, the more per diems.

The worst feature is the practical impossibility to stop either the witness or counsel from padding the record with testimony that would never be admissible were the trial in open court and questions could be ruled upon forthwith. It is not unusual for an expert witness to favor the court with his views on the witness stand for weeks and months at a time—"and, by the way, eminent counsel once defined an expert to be one who swears expertly."

It is not at all unusual for a suit involving fairly important issues to cost each side at the rate of from $10,000 to $20,000 per year. After all the testimony has been taken it is printed, an oral argument takes place, printed briefs are submitted, "and after the close of the arguments, if not before, the court goes to sleep, forgets the oral arguments, and after the lapse of considerable time renders an opinion resulting in a decree dismissing the complaint or directing an injunction and an accounting."

There is usually a stay of the accounting pending an appeal by the unsuccessful party to the Circuit Court of Appeals for that circuit, and if the decree of the court below is affirmed, testimony for an accounting is taken before a master and again all the elements combine to protract examinations and increase expenses. Except in extraordinarily important cases it is best to drop the accounting. The defendant is usually an irresponsible corporation or has lost or burned his books of account.

But the trouble does not end here. There is one United States, but there are nine Circuit Courts of Appeal of the United States of co-ordinate jurisdiction. For instance, the Second Circuit takes in New York, Connecticut and Vermont, but New Jersey and Pennsylvania are in the Third, and what is law in the Second Circuit in any particular case is not necessarily law in the Third, as the latter tribunal will frequently—"always with a heavy heart, however"—come to a diametrically opposite conclusion from that reached by the Second.

Therefore, if one gets an injuction in New York, say, against the "Excelsior" corporation, with a capital of $500, the incorporators can go to Hoboken and incorporate as the Hoboken Excelsior Co., and the whole lawsuit has now to go on all over again.

There is a possibility to petition the United States Supreme Court to review a decision of the Circuit Court of Appeals, but as this tribunal is exceedingly busy, most of such petitions are denied without an opinion, and "the result is that whenever a diversity of opinion exists between two Circuit Courts of Appeals as to the validity of a patent, and a petition for certiorari is denied you can keep on litigating and guessing which of the two courts is right, and the chance is one guess will be about as good as the other."

There have been attempts to create one Court of Appeals at Washington to which all appeals in patent cases would lie; but as the creation of such a court means the dispensation of patronage, Mr. Raegener thinks that another decade or so will expire before such an improvement can go into effect.

All judges are honest and learned, but the capacity and ability of judges in patent cases is "as varied as the colors of the rainbow."

"That patent lawyer is, indeed, inexperienced and careless if he does not carefully select his tribunal, so far as it is possible. For among the judges there are some who are so opposed to monopolies and patents that a mere look at the red seal and blue strings of letters patent incite them to such wrath that the patent is instantly doomed.

"Please don't think for a moment that this is a joke, because nobody has ever yet been able to define what is invention or discovery, and how much or how little genius must be shown, how laborious and how brilliant the work must be to dignify it with the name invention, and therefore any learned judge can always decree that the claims of the patent are void for lack of patentable novelty, and no tribunal can really settle that question in any particular case except a court of last resort like the United States Supreme Court.

"An infringer is called a tort feasor, and that is a bad

enough name; but a contributory infringer is the worst specimen of humanity imaginable." This theory of contributory infringement is, like alfalfa or Indian corn, the peculiar growth of our country.

"Under the law as made by the courts to-day you can sell your patented engines, your aluminium, your carbide and other patented products upon condition that the purchaser, as long as he uses your patented device or process, shall buy his flour, eggs, oatmeal or soap, his rat traps, furniture or whatever you please from you or your agents; and if any wicked provision or hardware dealer should be mean enough to sell any of these articles to your vendees with knowledge of these restrictions he becomes a contributory infringer, and you can annoy him and make him account for your losses.

"This country never does anything by halves. It gives the worst protection possible to the patentee seeking to enforce the rights plainly given him by the statutory law; on the other hand, by trick and device not found in the statutory law or in the patent laws of any other country, it enables him to hamper trade in the most beautiful manner possible.

"Of course, this theory of contributory infringement does much to make patent laws unpopular, and in the end the honest patentee will suffer."

As to remedies, Mr. Raegener emphasized that in England all patent suits are tried in open court and more quickly disposed of in consequence. In Germany every patent is absolutely valid after five years, and during the five years practically valid unless a proceeding is brought during this period in the Patent Office to vacate the patent.

Of course, neither in Great Britain nor in Germany are there nine courts of last resort and of co-ordinate jurisdiction. The necessity for establishing one tribunal of last resort, be it a special Court of Appeals or be it again the United States Supreme Court, seems "so self-evident that no man of ordinary intelligence can doubt it."

By united action inventors could do more to bring about the needed changes than by waiting for someone else to do the work.

* * *

Dr. B. C. Hesse, consulting chemist, of New York City, then made "some suggestions as to desirable improvements." He expressed the opinion that an inventor who allows his invention to lie idle, transgresses the spirit underlying the patent system. He is reserving for himself a field of endeavor which he has agreed to exploit and is not exploiting, and by his reservation he prevents its exploitation by others and thus retards progress.

A partial remedy for this might be a low annual tax, say, $15 or $25, or some other sum, not high enough to stand in the way of any invention giving any reasonable promise of remuneration, yet high enough to make it appear unprofitable to many to retain reservation in fields which they are either unwilling, unable or incompetent to develop.

It would be very wrong to believe that a patent when granted is valid to such an extent that any one contesting the legality of such reservation should be compelled to remain out of the field until he proves the contrary. Experience has led the courts to adopt a different view and in the majority of cases a patentee has to contend for the legality of his reservation, sometimes, if not generally, expending the greatest part of his energy in a litigated case in proving his title.

The reason for this seems to be that the courts have come to the conclusion that our system of preliminary examination does not properly safeguard the interests of the public. The remedy would, therefore, lie in the direction of improving or elaborating our system of preliminary examination, because an absolute abandonment of preliminary examination would be necessarily vicious.

The remedy which Dr. Hesse suggests is that after an application has been passed to allowance in the Patent Office the public, or so much of it as is interested, be given access to the disclosure of the invention and a reasonable time within which to oppose the final grant of the monopoly, as is done in Germany. A patent obtained under this mode to be given the right of preliminary injunction in its favor and all infringement or alleged infringement thereof to cease or to be prohibited pending final adjudication of the validity of the grant.

By this means the inventor, on the one hand, would receive a patent effectively shutting off infringement and consequent interference in his granted monopoly until his opponents have properly proven the illegality of the patent. The public, on the other hand, would be spared the issue of a very considerable number of patents presumably invalid and by exercising its rights to oppose the grant of patents of doubtful validity would save to itself many opportunities of endeavor and development and the expense and annoyance of proving in court the invalidity of a granted patent, together with the annoyance and interference which an invalid patent is capable of producing.

It should be noted that it is not contemplated to take from the public the right to attack the legality of the grant of the patent, but that that right remains fully open to the public throughout the entire life of the patent, subject to the condition that the patentee's rights must be fully respected until he is proven to be in wrongful possession.

* * *

"The Inventor's Standpoint" was discussed by Dr. L. H. Baekeland, the distinguished chemical inventor of Yonkers, N. Y. He emphasized that the patent laws of the United States have been conceived with an unparalleled spirit of liberality toward the inventor. The cost is small, the period of protection is long, more so than in other countries.

The patent examiners of the United States Patent Office are "able, earnest and fair," but they are "an underpaid, ill-recognized, unrewarded set of fine men." The attitude which the examiner takes in a case where things are not very clear is that of a representative of the average uninitiated public, and may be summed up in slang: "I am from Missouri," so that it becomes the task of the inventor of "showing" and "showing why."

In his own experience, Dr. Baekeland said, he had been thankful to the examiner several times for the objections made to text or claims, because the text was thereby shown to be not sufficiently explicit or concise, and by making the required amendments much future trouble was avoided in the eventuality of an infringement.

Dr. Baekeland thought he could hardly propose an improvement in the United States patent law without curtailing the privileges and interests of the poor inventor. But he suggested an act of reciprocity which would consist in exacting compulsory working of all patents taken here by non-citizens of the United States and whose countries have patent laws with a clause for compulsory working, which means great hardship for the American inventors who take our patents abroad.

The second part of Dr. Baekeland's paper dealt with the troubles experienced when it comes to testing the rights of the inventor before the courts. "Here the poor inventor is entirely at the mercy of the legalized system of piracy as carried out by infringers, helped by all the tricks of lawyers, and, let me say to the shame of our own profession, helped very often by experts who will back the lawyer to confuse an issue before a judge who most of the time is already incompetent in the art." Dr. Baekeland spoke of rich companies he knows in the United States whose main method of procedure is to frighten, bulldoze and ruin financially the unfortunate inventor who happens to have a patent which he is not willing to concede to them on their own terms; that is to say, for next to nothing.

Dr. Baekeland said he could cite several examples of prosperous companies where the money paid in salaries for the technical or scientific staff and for royalties is a mere bagatelle

if compared to the fortunes paid annually to the lawyers who happen to look after the patent litigation.

"The sooner we have a special and adequate patent court to which all patent litigation can be referred and which can operate without the absurd delays and abominable expenses now involved in patent suits, the sooner will cease this arrogant frustration of the generous efforts of those who framed our patent laws."

* * *

Dr. Hugo Schweitzer spoke briefly on some points raised by the various speakers. He also emphasized the importance of product patents for chemists.

Finally, attention was called to a bill now before Congress by which a final court would be created for the United States to which appeals in patent cases from the various District Courts would be made. (Concerning this bill, see the letter of Dr. Baekeland on page 56 of this issue.)

The Detinning Industry.

The Goldschmidt Detinning Company has been incorporated with a capital of $3,000,000 ($1,000,000 preferred and $2,000,000 common stock). The officers of the company are: Mr. W. T. Graham, president; Dr. F. H. Hirschland, vice-president and general manager; Mr. H. E. Rogers, secretary, and Mr. R. H. Ismon, treasurer. (Mr. Graham and Mr. Ismon are president and secretary respectively of the American Can Co.)

The company will operate under the patents of Dr. Karl Goldschmidt for the detinning of tin scrap by means of chlorine. The first works will be erected near Carteret, N. J., where the company has bought ten acres of land with waterfront. This plant will have a capacity of treating 30,000 tons of tin scrap per year and will start operation about October, 1909.

A second works is planned for the West.

The Goldschmidt chlorine detinning process to be used in these plants is already in commercial operation at the works of Theodor Goldschmidt in Essen. There it has supplanted the older electrolytic detinning process of Dr. Hans Goldschmidt, who is also the inventor of the well-known thermit process. The two brothers, Karl and Hans Goldschmidt, are

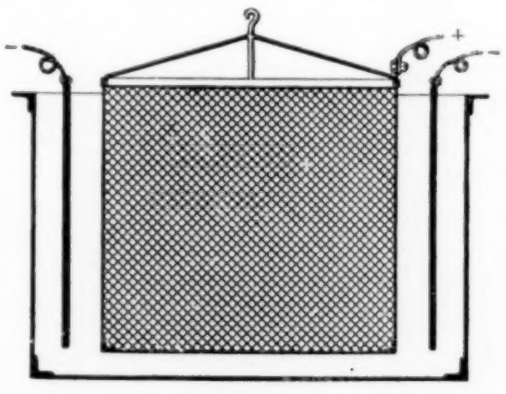


FIG. 1.—ELECTROLYTIC DETINNING CELL.

the owners of the tin and chemical works of Theodor Goldschmidt.

The Goldschmidt chlorine detinning process is also in commercial operation at the works of Gillet Fils in Lyons, France, one of the largest silk factories of the world.

The new works of the Goldschmidt Detinning Company will have their own liquid chlorine plant. The chlorine gas is to be furnished from the Wyandotte Works of the Pennsylvania Salt Mfg. Co.

This will be the first time that liquid chlorine will become commercially available in this country and enter into competition with bleaching powder.

It will also be for the first time that anhydrous tetrachloride of tin will be manufactured commercially in this country, though it has already been imported lately into this country by the Consolidated Color & Chemical Company of New York City from the Essen Works of Theodor Goldschmidt.

While the electrolytic detinning process has been kept a secret process, the chlorine detinning process is protected by patents. The important ones in this respect have all been noticed formerly in our columns, but a review of the whole present situation, covering both the electrolytic and chlorine detinning processes, should be particularly welcome at the present moment.

Such a review has been given by Dr. KARL GOLDSCHMIDT before the general meeting of the Verein Deutscher Eisenhüttenleute in December. In view of the authoritative character of this paper we reproduce it below in full, as far as it deals with the engineering problems of detinning. Only those parts which deal especially with German conditions are omitted. The full German text of the paper may be found in *Stahl und Eisen* of December 30.

Electrolytic Detinning.

As early as 1876 Keith (U. S. Patent 176,658) recommended to treat tin scrap by electrolysis in an alkaline solution. The firm of Theodor Goldschmidt began their work in this line in

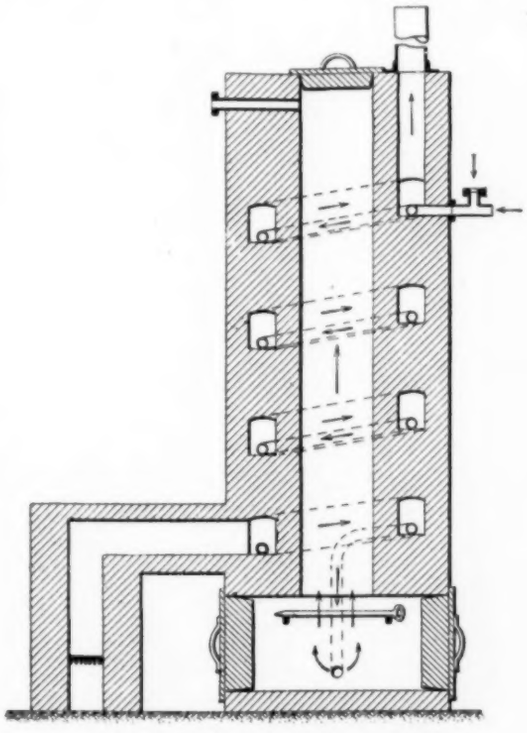


FIG. 2.—LAMBOTTE DETINNING FURNACE.

1882, using the tin scrap as anode and iron plates as cathode in an artificially heated solution of caustic soda. This idea is the foundation of the electrolytic detinning industry. But while the laboratory experiment is simple, the conditions in practice are difficult.

If we describe the reaction in an old-fashioned simple way, leaving the modern ionic theory out of consideration, we may say that the electric current decomposes the water and gives oxygen at the anode, forming tin oxide which dissolves in the excess of caustic soda to form sodium stannate, while hydrogen is developed at the cathode and at once precipitates the tin on the cathode from the solution.

The presence of free caustic soda is, therefore, a fundamental requirement. But caustic soda continually attracts carbonic acid from the air, forming sodium carbonate. Further, more tin is dissolved from the anode than deposited on the cath-

ode, on account of the much greater surface of the former compared with the latter. The free caustic soda has, therefore, a tendency soon to disappear and the electrolyte then becomes ineffective. It is thus of fundamental importance to maintain continually a certain excess of free caustic soda.

If this excess becomes too small, the detinning is not perfect and not only is the tin output reduced, but the quality of the steel is bad, as it contains too much tin for use in open-hearth works.

In the devices for artificially heating the cells care must be taken to prevent short-circuits, which would reduce the efficiency.

The tin scrap is always placed in a basket connected to the positive pole, as shown in Fig. 1. The construction of this basket involves difficulties. It must be of moderate size, since otherwise the tin scrap in the center would not be detinned. Further, the tin scrap is rather voluminous and cannot be used in compressed form, since the electrolyte should have free access to all surfaces. This means a small weight of tin scrap (only 10 to 20 kg) per basket, and, therefore, considerable expense for wages.

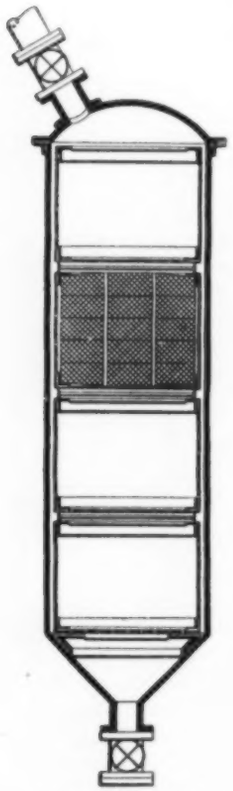


FIG. 3.—CHLORINE DETINNING APPARATUS.

Only by very careful working and by giving continual attention to the right composition of the electrolyte it is possible to remove the tin so perfectly from the sheet iron that the latter can be sold to open-hearth plants. Even with very careful working, there will remain 0.1 to 0.2 per cent of tin on the iron, often more, like 0.3 to 0.5 per cent. Anyway, the iron is suitable for open-hearth practice.

The tin is obtained on the cathode in form of a spongy deposit. This may be easily removed and remelted, to get it in salable form.

The weak points of the process are the necessity of careful attendance and of small units (which means high wages) and a considerable loss of tin. This loss of tin is due to the fact that when the detinned iron is taken from the cells, a considerable quantity of the electrolyte which is rich in tin adheres to the surface. As the surface of tin scrap, treated per day in the Goldschmidt works, in Essen, covers an area of not less than 20 Prussian morgens (= 12½ acres), the quantity of electrolyte lost daily is quite considerable, even if only a small amount of tin electrolyte adheres to the surface. By washing with water a tin-containing precipitate of very little value is obtained.

The solid tin obtained by remelting the spongy cathodic tin is 97 to 98 per cent pure; some additions of lead cannot be avoided even if great care is taken.

Chlorine Detinning.

While 25 years ago the electrolytic detinning industry became possible with the advent of electric current supply on a commercial scale, the chlorine-detinning industry is the result of the availability of cheap electrolytic chlorine and the possibility of liquefying it.

In the middle of the last century Higgins (English patent 766, 1854), later Parmela (United States patent 102,148, 1870), Seeley (United States patent 127,375, 1872), and Panton (United States patent 135,578, 1873), attempted to detin tin scrap with chlorine.

It was early recognized that dry chlorine gas was necessary. Dry chlorine gas combines with tin with evolution of considerable heat, forming anhydrous tin tetrachloride, which is a heavy fuming liquid, already known to Libavius in 1605.

If dry chlorine gas is carried over and through tin scrap, the chlorine and tin combine, forming tin tetrachloride, which drops off. Dry chlorine does not attack the iron. The process is, therefore, very simple, but it took some 50 years to reduce it to commercial practice.

The difficulties were manifold. Firstly, methods had to be developed to cheaply produce and ship chlorine. Further, after treatment with chlorine, the surfaces of the scrap are covered with a film of a fuming and very obnoxious fluid which has a very bad effect on eyes and nose of the attendants. To remove this film was absolutely necessary; but the use of water for washing was impossible since a solution of tetrachloride attacks the iron so that both the iron and the tetrachloride become useless for commercial applications.

Even if the anhydrous tetrachloride is removed, the iron will quickly rust so as not to have any commercial value.

The first who carried out detinning by means of chlorine was Lambotte, who built a larger plant in Brussels, in the eighties, the arrangement being shown in Fig. 2. It is a shaft furnace through which the tin scrap is carried downward from above, while chlorine gas, diluted with air, is introduced at the bottom (German patent 32,517, 1884).

The chlorine combines with the tin and the air carries the tetrachloride of tin into a condensing apparatus. The detinned iron-scrap bundles are removed from the bottom of the furnace.

The chief difficulty of this process was that the iron scrap was exceedingly liable to rust, as with all former processes of detinning with chlorine. Even if all moisture was carefully avoided, and the resulting steel-gray iron was stored in a very dry place, it would rust and the corrosion would continue to proceed very quickly. The reason of the corrosion was found in the fact that the chlorine is not absolutely without any attack on the iron, but forms a very thin invisible film of anhydrous ferric chloride on the surface of iron. If the iron is exposed to air the anhydrous ferric chloride will attract water from the air and rusting would result. The ferric chloride is reduced to ferrous chloride and this attracts again oxygen and water from the air, forming oxychloride; this is again reduced by the iron, forming rust, and so on. Only when this fact had been found the corrosion of the iron was prevented by removing the ferric chloride film by a washing process (German patent 176,457, see our Vol. IV, page 501).

The tin scrap must be dry and free from all organic substances, paper, lacquer, etc. It is necessary to remove not only any adhering moisture, but anything that can form water. Tin tetrachloride is a substance which attracts water with great avidity and carburizes organic substances. Every chlorine detinning apparatus should therefore be marked: Extra Dry.

The tin scrap is compressed into bundles (in which form they are later sold to the open-hearth steel works) and placed into cylinders, which are then closed. (Fig. 3.) Chlorine gas is then introduced. It is important to prevent an undue rise of temperature (German patent 188,018). As tin and chlorine when combining to tin tetrachlorine develop considerable heat, artificial cooling must be provided.

To detin the scrap completely it is necessary to use the chlorine at a pressure of several atmospheres so that it enters all crevices. When the gaseous chlorine forms liquid tin tetrachloride, the pressure is reduced. As long as the pressure continues to drop, detinning takes place. When the pressure remains constant for some time, it is evident that the chlorine does not find any more tin to combine with. This is a sure indication that the detinning operation is completed.

The chlorine and tin tetrachloride are removed, the iron scrap bundles are carefully washed, and are then ready for delivery to the open-hearth steel works.

The chief advantage of the chlorine detinning process over the electrolytic process is that there is very little expense for

attendance, as the scrap is passed in large bundles through the process. The process is completed in one single operation. The tin tetrachloride is a valuable product for its use in silk mills.

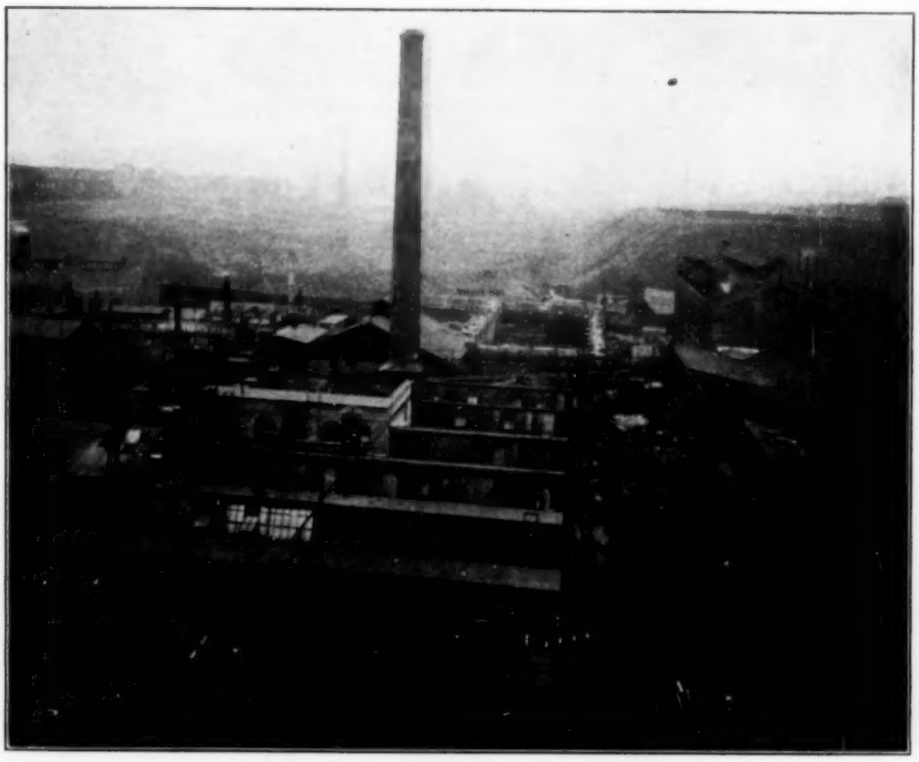


FIG. 4.—GOLDSCHMIDT TIN AND CHEMICAL WORKS IN ESSEN.

The iron is detinned by this process more completely than by the electrolytic process. No tin is lost in washing.

With respect to the analysis of detinned iron, chemists are liable to make the mistake of using too small quantities. By analyzing 10 grams it is quite possible to find no tin, while the iron surfaces may contain considerable tin at other points. To get a good average sample, the practice in the Goldschmidt works is to dissolve always 3 kg in hydrochloric acid; the result is considered satisfactory only if the analysis gives considerably less than 0.1 per cent tin.

Detinning of Old Cans.

Formerly only the scrap from the tin-can factories was detinned. This was a very pure starting material for the detinning process. But with the growth of the detinning industry, the demand for such tin scrap has become greater than the supply, and while such scrap could be had for nothing 20 years ago, it is now rather expensive.

Naturally many attempts have been made to make the enormous supply of old, used tin cans available for detinning. But this has great difficulties. There are not only the impurities from the former contents of the cans (eatables, etc.), but also the paper labels, the solder containing lead, and the thin rubber ring which in folding the edges of the tins is placed in the fold to make it tight. Further, the cans are very voluminous.

The cans are first compressed and, by means of rolls with sharp cutting points, they are provided with a great many holes and cuts. Any adhering fat, lacquer, etc., is then removed by washing in caustic soda solution. The cans are then washed in pure water, and the solder and rubber rings are removed by heat in a furnace. The tin cans are now pure iron and tin and are compressed into bundles for detinning.

Tin cans which have not been cleaned in this way yield little tin in the detinning process, while the iron is of inferior quality.

The tin scrap is obtained from the tin-can factories in all parts of the world and shipped to the detinning works; from Italy (sardine boxes), from Egypt (cigarette boxes), from Newfoundland (lobsters), from Norway (fish conserves), from Switzerland (condensed milk), etc. To detin the scrap right at these places would not pay, because the quantity of available scrap would be generally insufficient; further, the detinned iron would have to be shipped anyway to the steel works, and it weighs almost as much as the scrap.

The detinning industry of Germany treats per year about 75,000 tons of scrap. Of these, 50,000 tons are detinned in the Goldschmidt works, in Essen, and the balance of 25,000 tons in 8 or 10 smaller works. Small works are, however, hardly economical and their troubles are increasing.

In other European countries somewhat over 25,000 tons of tin scrap are detinned per year; in the United States about 60,000 tons. The total for the world is, therefore, 160,000 tons scrap, yielding 3000 to 3500 tons of tin, which is 3½ per cent of the total yearly output of tin. When the treatment of old tin cans will assume greater proportions, the output of the detinning works will, of course, greatly increase.

The weight of the detinned iron is about the same as that of the tin scrap, that is, about 75,000 tons of iron per year in Germany. The detinning industry is, therefore, not so absolutely unimportant for the steel industry; one may remember the old farmer's saying: "Kleinvieh macht auch Mist."

Notes on Electrochemistry and Metallurgy in Great Britain.

(From our Special Correspondent.)

The Physical Society's Annual Exhibition of Apparatus.

The fourth annual exhibition of electrical, optical and other physical apparatus was held at the Royal College of Science, South Kensington, on Dec. 11, 1908. Invitations were extended to members of kindred institutions, and there was a good attendance to view a decidedly interesting collection of exhibits which fully maintained the standards of previous years.

The Cambridge Scientific Instrument Co., Ltd., showed their vibrating-tongue extensometer, said to detect an extension of one part in a million without mirrors or microscope; Callendar & Barnes' continuous-flow calorimeter; Méker burners and furnaces—the latter being capable of melting platinum with an air blast; the Féry radiation pyrometer, and Joly's meldometer for determining melting points of minerals, etc., with very small samples.

Messrs. C. F. Cassella & Co. gave practical demonstrations with Capt. Sankey's new machine for rapidly testing steel and other metals. The test occupies about one minute; and an automatically plotted record gives the number of bends, bending effort in foot-pounds, and total energy required to break the test piece.

Among the exhibits of Messrs. A. C. Cossor, Ltd., was the "Rose" vacuum pump for rapidly producing very high vacua. The piston is operated by an electromagnet; there is not any

mechanical connection through the cylinder to the piston, and so leakage is impossible.

Messrs. Eliott Bros. had, among their several instruments, a moving-coil leakage indicator, a portable alternating-current standard wattmeter, and also their "reflectroscope" for projection of opaque objects in natural colors. In this apparatus the rays are parallel, and delicate specimens may be exhibited without injury by heat.

Messrs. Everett, Edgcumbe Co.'s high- and extra-high-tension (Jona pattern) electrostatic voltmeters present new and distinguishing features. The instrument shown had a double range, from 12,000 to 60,000 volts. A self-contained portable potentiometer designed for checking ammeters, voltmeters, wattmeters and for photometer work, deserve special notice.

A notable feature of Messrs. A. Gallenkamp's apparatus was a cheap electric tube-furnace, having no platinum in its construction, for temperatures up to 1000° C.

Messrs. J. J. Griffin & Son had several types of electric furnaces, including one in which only one-sixth of the platinum ordinarily required was employed in the form of strips of foil. Their quartz-glass amalgam lamp, giving a strong ultraviolet spectrum, attracted considerable attention. They also showed platinum resistance thermometers with quartz insulation and mounted in quartz-glass tubes, the resistance wires being completely protected from the action of gases.

Messrs. A. Hilger's exhibit was most interesting, and included their wave-length spectroscope, reading direct on a spiral drum; an echelon spectroscope and 20-plate echelon grating, and a large quartz spectroscope giving a spectrum 200 mm in length.

Mr. Hans Knudsen showed his ingenious apparatus for wireless transmission of photographs.

Marconi's Wireless Telegraph Co. had on view a new multiple tuner for wireless receivers, which is said to secure a high degree of immunity from interference.

Messrs. Nalder Bros. and Thompson's telethermometer is a new instrument which indicates temperature electrically with rapidity and great accuracy.

Mr. Robert W. Paul had a good assortment of electrical instruments, and showed Irwin's hot-wire oscillograph at work recording alternating-current wave-forms. A special form of camera takes photographic records.

Messrs. Pitkin & Co. exhibited their latest laboratory and workshop types of Holden-D'Arsonval galvanometer, and the Roberts-Austen recording pyrometer now used at Woolwich Arsenal, which enables the temperature to be observed externally at any moment without interference with the record.

Messrs. Siemens Bros. & Co. had an attractive exhibit from which we select for mention their apparatus for rectifying alternating currents of 100 to 600 volts; a portable current transformer for accurate laboratory work, in which the ratio is constant from 10 per cent up to 100 per cent of rated load; dynamometer-principle ammeters and wattmeters and a testing magnetizing apparatus.

Messrs. Snell & Tinsley's leading items were Drysdale's standard wattmeter, giving accurate readings on the lowest available power factor; and a Tinsley direct-reading potentiometer designed for work with from 1.8 to 2.2 volts, between which limits adjustment to 0.0001 volt can be made without additional rheostats.

Messrs. Strange & Graham's apparatus for making metal ribbons was shown working. The molten metal flows from a suitable orifice onto the periphery of a rotating, water-cooled drum. Solidification is apparently instantaneous, and the metal is thrown to a distance of several feet in a continuous ribbon surprisingly uniform in thickness and width.

Messrs. Carl Zeiss's demonstration of their projection apparatus for fluid crystals was much admired. The apparatus consists of an optical bench with an automatic-feeding 20-amp arc lamp, and provided with an excellent combination for microscopic projection from cells in which the formation and liquefaction of various crystals are brought about by carefully arranged heating apparatus fitted to the sub-stage and a cooling apparatus above the mechanical stage. The polarizer and analyzer of the microscope are specially constructed, and the body tube is of large diameter to permit low- and high-power work without diminution of the field.

Faraday Society.

The following papers were read at the meeting of Dec. 15: "The Redetermination of the Electrolytic Potentials of Silver and Thallium," by Dr. F. J. Brislee; "The Heats of Combustion of Aluminium, Calcium and Magnesium," by F. E. Weston and H. R. Ellis; "The Formation of Graphite by the Interaction of Magnesium Powder and Carbonates," by H. R. Ellis, and "Colloidal Barium Sulphate," by Dr. E. Feilmann.

With respect to Dr. Brislee's paper on the electrolytic potentials of silver and thallium, Dr. Abegg (Breslau), in a communication, pointed out that Dr. Cumming had already found, and published in the *Transactions* of the Faraday Society, that ammonium nitrate solutions are not applicable for eliminating liquid potential between basic solutions. He expressed the hope that the symbols proposed by the Bunsen-Gesellschaft in 1903, and accepted by the fifth international congress of applied chemistry, at Berlin, the same year, might be adopted in Great Britain.

Dr. G. Senter inquired whether the variations in the results obtained by the author would not be accounted for by slight differences in temperature.

The chairman, with reference to Dr. Senter's question, said he was of opinion that some methods, such as those employed by the author, were attended by an appearance of accuracy which was rather fictitious and which the experimental results did not justify.

In the discussion on Messrs. Weston and Ellis's paper, a communication by Dr. Borns pointed out that, although Mr. Weston had said that he was repeating his experiments *in vacuo*, such experiments as those detailed by the authors could not render reliable results as to the uncertain heats of formation of the oxides of aluminium, calcium and magnesium. Mr. Weston was working in air, and powdered his metals; the mixtures presumably stood for hours, and it was doubtful whether the metals were free from oxide when the experiments were started. Shavings of electrolytic calcium, turned on a lathe, could hardly be free from oxide.

H. K. Picard said that while assisting M. Vautin in his early experiments on what is now known as the "thermit" process, he had carried out a large number of reductions of oxides and sulphides by aluminium, and had arrived at the same conclusions as the authors. The study of the reaction between alumina and aluminium sulphate would be interesting. He had not succeeded in bringing it about, but saw no reason why it should not be effected, although it was always impeded by formation of aluminium suboxide. As a possible method of manufacturing aluminium, he commended it to the authors for an experimental investigation.

Dr. N. T. M. Wilsmore was in agreement with the view that the reactions were too complicated to warrant deductions from the heats of formation of simple oxides. In answer to Dr. Borns, he thought metallic calcium was nearly as stable as magnesium.

Mr. H. R. Ellis replied that the nitride formed when magnesium was employed in the reductions was evidently not magnesium nitride. When magnesium is burned in air, or when it reduces an oxide of a metal which does not form a nitride, only a very small amount of nitride is produced; and as magnesium nitride readily burns to oxide when heated, the great evolution of heat attending the combustion would destroy any nitride when magnesium is burned in air or when the powdered metal reduces an oxide which has a small heat formation. The reduction of copper oxide by Mg evolves 111,000 calories, but that of calcium oxide only 3000 calories. In the latter case formation of magnesium nitride might be expected; but, al-

though an excess of Mg increases the quantity of nitride, it is never greater than the calcium accounts for, and, moreover, strontium and barium oxides, with a much higher evolution of heat, give a greater yield of nitride, while silica and boron-trioxide are reduced by Mg with a very small yield of nitride and only a moderate evolution of heat—20,000 calories and 42,000 calories, respectively.

On Mr. H. R. Ellis' paper, Dr. Borns remarked, in a communication, that the author's results were of very great interest. The combustions were started by magnesium, and in such cases ammonia might be formed from magnesium nitride. It was well known that carbide and nitrogen alone would yield hardly any cyanamide, and the presence of some other substance was necessary to render the process remunerative. Some investigators had recommended the use of calcium carbonate for this purpose.

With respect to Dr. Feilmann's paper on "Colloidal Barium Sulphate," Dr. V. H. Veley (communicated) remarked that from the description of the liquids as having "the appearance of ordinary milk, by reflected light," it seemed that they were of the nature of emulsions, and their general properties are similar to those described by Pickering in *Trans. Chem. Soc.*, 1907, 2001. A fuller examination into the dimensions of the particles of barium sulphate was desirable. He had ascertained the size of particles of barium sulphate precipitated from the chloride by a sulphate without free acid—which gives a more crystalline and coarser-grained precipitate—and found the average diameter was 0.001 mm to 0.002 mm. The edges were sharp and well defined. Particles of the collodial sulphate would probably be larger and without definite edges. With a microscope of high power and a hot stage, the temperature of transition from the colloidal to the crystalline condition could be ascertained by slowly melting off the organic menstruum. The conditions of precipitation by acids and re-solution by alkalies could be studied, and more information obtained as to the sizes of the particles according to the nature and concentration of the acid or alkali. It appeared possible that by repeating the experiments of Lodge (Brit. Asso. *Report*, 1884, 309), varying the conditions of diameter of tube, potential and current, every variety from well-defined cystals to amorphous masses could be obtained.

Professor Haldane Gee (communicated) observed that since the work of Graham, in 1861, colloidal chemistry has been much extended in its scope, and promises to become a very important branch of physical chemistry and fertile in technical applications. The action of organic colloids in producing stable colloidal solutions has not been completely explained. That the particles seem to be coated by the protector is in accordance with the fact —shown by Quincke—that given three immissible liquids, *A*, *B* and *C*, then *B* will tend to form a layer separating the others if the sum of the surface tensions between *A* and *B* + *B* and *C* is less than the surface tension between *A* and *C*. It had been suggested that the coating may form a permanent electric "double layer" preventing the neutralization of the nucleus by ions of an opposite charge. The extension of the author's method to calcium salts would be interesting. Using albumen and like substances much might be learned of the method of production of dentine and other hard substances in the animal tissues.

Dr. G. Senter understood the author to mean that the barium sulphate was not truly in a colloidal state, but in crystalline particles surrounded by casein. That was not in agreement with Dr. Veley's views. Could the question be settled by vigorous scrubbing of the particles with sand, and observing if a colloidal solution would still be formed? He suggested examination with the ultra-microscope, and also the employment of a smaller proportion of casein.

Dr. Borns, with reference to the point raised by Dr. Senter, stated that other investigations dissolve barium oxide in aqueous methyl alcohol, pass CO_2 through the solution, and obtain a gelatinous solution perfectly soluble in water so long as any methyl alcohol remains, and forming colloidal barium sulphate with sulphuric acid. Here there was not any colloidal envelope for the particles. He suggested the employment of colloidal barium sulphate for coating the interior of the copper globe of a certain street photometer, recently exhibited in London, instead of the ordinary sulphate.

Market Report for December.

Tin has fallen considerably, from £134 10 0 on the 1st to £131 on Dec. 7th, rose again to £132 on the 10th, and had a sharp drop to £130 10 0 by the 14th. Since recovered to £131.

Copper has been fairly steady in the neighborhood of £62 during the month, with sharp rise from £62 5 0 on the 5th to £64 on the 10th. Now at £63 10 0.

Pig Iron (*Cleveland*) has risen slightly from the original quotations; dropped slowly to 48/- during the month, but recovered to 49/3.

Scotch Pig has been down to 54/-, but recovered to original quotation, 55/6.

Hematite dropped from 58/- to 57/6.

Lead stead at £13 10 0.

Other prices were as follows during December:

Antimony, Star Regulus, per ton	£32 0 0 to	£34	0 0
Ammonia Sulphate, f. o. b. Liverpool, per ton		24	0 0
Copper Sulphate, per ton		20	10 0
Bleaching Powder, 35 per cent, per ton		4	5 0
White Caustic Soda, 77 per cent, per ton		11	2 6
Carbolic Acid Liquid, 97/99 per cent, per gal			1 0
Creosote, ordinary good liquid, per gal			2¾
Naphtha Solvent, 90 per cent at 160 deg. C., f. o. b., per gal.			11½
Pitch, f. a. s. Manchester, per ton			18 0
Shellac, Standard T. N. Orange spots, per cwt		4	10 0
Benzole, 50/90 per cent, per gal			6
Rubber, Para fine, per lb			5 1

SYNOPSIS OF PERIODICAL LITERATURE.

Iron and Steel.

Blast Furnace Explosions.—The great loss of property and life accompanying the explosions which sometimes follow a slip in the blast furnace has made these accidents the center of a great amount of study. In *Stahl u. Eisen* for July 15, W. Van Vloten communicated an article on the cause of these explosions and recently in the December 2 number of the same journal further correspondence appears on the same subject by Teichgraber and Osann. Van Vloten's original conclusion as to the cause of these explosions was in the fact that following a slip an intimate mixture of fine ore and coke was suddenly dropped into a hot zone, with the resulting formation, if both coke and ore were hot, of a large volume of CO according to the usual reaction of reduction. The high temperature of the region in which this gas was formed also greatly increased its normal volume. The explosions cannot be conceived to have been produced by the agency of air, as air cannot be introduced into the region in which they apparently take place. In support of this theory the author took a large diameter iron tube, inside of which he placed at one end two shorter and smaller diameter tubes filled with ore, the space around the smaller tubes being filled with coke dust. The whole was heated to redness and sudenly inverted, mixing the red-hot ore and coke in the end of the large tube. On this mixing of the ore and coke a manometer on the large tube suddenly recorded a pressure of four atmospheres. No explanation is given of the reason why explosions are more frequent when charging is done too much in the middle of the furnace, though this is recognized as a source of danger. Teichgraber offers a simpler explanation. An arch is formed of the stock in the furnace, this arch permitting of the formation of a hollow space underneath. The arch collapses and forms a second hollow space above the former. In the formation of this second hollow space air is pulled in from the top and mixes with gas in this hollow and causes the explosion. The remedy is to keep the top of the furnace closed or else introduce gas there from another furnace when the explosion is about to occur; in other words, until a slip is likely to take place. Osann does not believe that it is possible for the reaction Van Vloten quotes to take place so rapidly as to cause the great increase in

pressure given because it is an endothermic one, and endothermic reactions cannot be explosive in character. He claims the explosion is not a true explosion, but merely an expulsion of a large quantity of gas which carries with it some of the stock, the expulsion being due to the arching of the charge with the formation of a hollow underneath the arch. On the collapse of the arch this gas in the hollow space is expelled from the furnace.

Van Vloten ridicules both explanations on the grounds: The explosion takes place when the top of the furnace is closed and so no air can be sucked in; again, even when an arch falls into a hollow space, the total volume of the furnace stack is constant and the amount of material in it is the same, therefore without gas generation or some other cause of sudden increase in volume there should be no explosion. In case of the reaction being endothermic, the residual or sensible heat in the ore and coke is quite sufficient to cause it to take place.

Styrian Steels.—The careful methods used in the manufacture of the high-grade Styrian steels have recently been described in *Stahl und Eisen* and later translated into *Iron Age*, this abstract having been taken from the former journal. This district is one of the richest in Europe in iron ores. They were mined here and iron was produced in the early Roman period, the methods in vogue still being many years behind modern practice, but the Styrian iron masters are loath to give up their proven methods for more modern ones until they are assured of the same high quality of product. The Kappenberg works, the most famous of them all, were founded in 1446, though at present a modern electrical equipment in the shape of handling appliances, annealing and melting furnaces is being installed. The graphite crucibles used in melting the steel are used only once, it having been found that the reactions produced by the crucibles are not the same the second melting as the first and so to use them a second time would be to sacrifice the one quality of product they pride themselves on—uniformity. These crucibles are made on the premises, the graphite used in them analyzing C 77.80, SiO_2 13.04, Al_2O_3 6.12, Fe_2O_3 0.44, P_2O_5 0.01, K_2O 0.43, H_2O 1.95. The crucibles are in the drying house six to seven weeks. The ore used in the blast furnace analyzes Fe 38.9 per cent, Mn 2.1, P 0.17, S and Cu traces. The blast furnaces are 40 ft. to 50 ft. high and in outward appearance resemble medieval castles. In making white iron 1300 lb. and in making gray iron 1500 lb. of charcoal are used per ton of iron. The pig iron is converted into steel in a charcoal finery, taking for this operation as many days as the puddle furnace hours or the Bessemer converter minutes. This furnace consists of a shallow pit lined on four sides with iron plates, above one there being placed a slanting tuyere. The pit is filled with charcoal and on this is placed the iron to be melted down. In refining gray iron, three meltings are required, the first taking out the silicon and most of the manganese with a small portion of the carbon. The second melting takes out more of the carbon, the third step completing the removal of the carbon. White iron requires one less melting. If steel is to be made, one less melting is required. The soft iron made in this way does not contain, excepting the carbon, more than 0.09 per cent foreign elements, of which more than half is usually manganese. Only 40 to 50 crucibles are melted at one time in a furnace to insure all having exactly the same temperature. The crucibles are preheated in two forewarmers at 400° and 800° for four hours each before entering the melting furnace. All ingots are hammer forged.

Steel Pipe.—Last year there was a million and a half tons of welded pipe produced in this country, 80 per cent of which was of steel. This pipe is being used for all sorts of purposes, its merits for water and gas mains being discussed in a paper read at the October meeting of the American Gas Institute by Mr. F. W. Speller. Steel pipe is about twice as strong as iron pipe and shows the same proportionate resistivity to alternate stresses. It is necessary to pay much greater attention to the threading of steel pipe, its greater hardness requiring a different form of die if the pipe is to be gas-tight when screwed together dry. Considerable attention to the corrosion of the two kinds of pipe was given, with the conclusion from the work of Howe and others that steel pipe is at least no more subject to corrosion than iron pipe and in many cases stands up better.

Cupola.—At the Toronto meeting of the American Foundrymen's Association an interesting discussion arose on the merits of the Balliot cupola. The main feature of this cupola are the use of a double row of tuyeres, even supplemented by a third row at some distance from the others so as to ensure as complete combustion as possible, and the return of a part of the gases from the top of the cupola to the zone of combustions. These returned gases to be effective should be as rich in steam and carbon dioxide as possible. The return of this waste gas prevents too high a temperature in the usual low zone of combustion and extends this zone to a considerable distance up the stack by the use of the multiple rows of tuyeres. A ring at the top of the stack allows of the preheating of some of the air used, also leading to economy. More data is required on the actual behavior of this cupola in practice before criticizing or condemning it.

Iron and Steel Institute.

PAPERS READ AT THE MIDDLESBOROUGH MEETING.

A Workshop Microscope.—J. E. Stead points out that for this purpose the microscope must be simple. Few parts are essential and rough handling is to be expected of such an instrument in the shop. The microscope described uses as source of light a low-voltage electric lamp fed from the shop circuit if available or from storage batteries in case such is not at hand. This lamp is placed in a tube joining the optical tube of the instrument at right angles. For low powers the light is reflected to the work by means of a mirror, the objective being above the source of light and its mirror. For high powers the light is reflected down through the objective by means of the ordinary plane-glass illuminator, and back through the optical tube of the instrument. The advantage of placing such an instrument in the hands of the shop foreman for examination of the surface of castings, semi-finished pieces, etc., is readily seen.

Metal Mixer and the Open-Hearth Furnace.—A. E. Pratt points out that the metal mixer is not only used to-day to ensure a certain uniformity in the metal charged into the open-hearth furnace, but has recently taken on the rôle of a partial refiner. Desulphurization by the use of manganese is commonly carried out in this apparatus. By maintaining a cover of basic slag in the mixer, especially if high in oxides of iron, a surprising elimination of impurities may be accomplished. Fluorspar is commonly added to ensure the fluidity of this slag. The author proposes the following modification of the open-hearth practice as a means of using this apparatus to its full advantage:

In the open-hearth process three periods are recognized in the reactions taking place: (1) A melting down of the pig if charged solid; (2) low-temperature portion of the operation in which the larger part of the metalloids are removed, but a small portion of the carbon being oxidized; (3) high-temperature portion of the operation in which the remainder of the carbon is removed with the rest of the metalloids. In ordinary practice it is true these three periods merge into one another, but they do so only at the expense of efficiency, for the metalloids are but poorly removed at high temperatures and carbon is but inefficiently removed at low temperatures. For ideal working each should take place at its own temperature of maximum efficiency independent of the other. The proposed method is really designed to do away with these transition periods. A large gas fired metal mixer called the "finer" is charged with raw metal and materials to make a covering of highly basic slag, this slag being removed from time to time as it becomes foul and replaced by fresh oxides. The temperature of this "finer" is run low, that at which the metalloids are removed at greatest efficiency. Carbon is not to be removed in this furnace.

A second furnace called the "scrapper," of similar design to the finer, but connected to a larger gas supply and capable of being run at a maximum temperature, is used to heat scrap to the highest possible temperature. These furnaces should be tilting furnaces, best of the Talbot type in which charging and tapping may be continuous. A third series of furnaces known as "finishers," similar to the ordinary type of open-hearth furnace, are charged with metal from the scrapper and into which metal is run from the finer. The reaction which takes place on running this finer metal into the hot scrapper metal is most violent and carbon is practically instantaneously eliminated. It is advised to add preheated lime and oxides to the scrapper metal as it is poured into the finisher, or the same may be preheated in this last furnace and the scrapper metal run in on top. The bath is finished in the usual way.

Where large quantities of scrap are not available a modification of the process is recommended. A Talbot furnace is charged with finer metal and heats this charge to a high temperature. Oxides are added in small portions to remove the carbon from this high temperature metal and more finer metal and oxides charged. The advantages claimed for the process are continuity, increased yield, rapid working, a marketable finer slag to be used as fertilizer, low labor costs, uniform temperature in each furnace tending to long life of the same, high-grade output, insures a regular supply of metal to the mills, no furnace is kept waiting for metal, there is no large stock of dead soft metal locked up the process, a triplicate plant is not really necessary as all are working at the same time at their maximum efficiency.

Oval Blast Furnace at Newport.—The modern American blast furnace, with a 13-ft. diameter tuyere section, requires high-pressure blast to insure complete combustion to the middle of the section. High-pressure blast engines are expensive pieces of apparatus to install and run. For this reason a means was sought to obtain the output of such a furnace with a cheaper blowing equipment. It was desired to replace the 15-lb. blast pressure with one of six and to do this an oval cross-section of the furnace was determined on. The tuyere section of the furnace as built is 9 ft. x 17 ft. approximately, the section being oval to the top. The height of the furnace is about 80 ft. The furnace is claimed to be a success in every way, though but few details of its running were given.

Testing the Wearing Qualities of Steel Rails.—E. H. Saniter points out that for a long time the wearing quality of steel rails has been determined from the hardness of the rail, this property being usually determined by Brinell's method. A machine described in this paper is designed to determine this property from a test specimen. A cylindrical test piece is cut from the head of the rail, this test piece being chucked to a revolving shaft. A ring of hardened steel accurately fits this test piece, this ring in turn fitting into a bearing ring, a ball-bearing reducing friction between the hardened ring and the bearing ring. A load may be placed on the bearing ring, the hardened ring being carried around with the test piece by the friction between the test piece and the hardened ring. On revolving the test piece it suffers wear from this friction and the wearing qualities of the rail is represented by a factor, the number of ten thousandths of an inch in diameter worn down of the test piece in 200,000 revolutions. For instance, a nickel steel rail, 3.5 Ni, showed the factor 28, while ordinary carbon rails show factors between 45 and 65.

Copper.

Analysis for Copper Refineries.—The *Chemical Engineer* for October contains a scheme by Robert Kann for the complete works analysis of the electrolyte used in copper refining. In brief the methods used are as follows: Determination of copper: 10 cc of solution are diluted to 100 cc and the copper precipitated by boiling with sheet Al. Filter, dissolve the Cu in HNO_3, evaporate to remove NO, add tartaric acid, excess of ammonia and titrate with KCN. Iron: Oxidize 25 cc with HNO_3, boil, add ammonia, boil again, filter, wash, dissolve precipitate in HCl, pass in H_2S, filter, wash, oxidize filtrate, precipitate with amommia, wash, ignite and weight as Fe_2O_3. It is better to determine with $KMnO_4$ if standard solution is prepared. Calcium: 25 cc should be made alkaline with ammonia and precipitated with ammonium oxalate. Boil, let settle, filter, wash with hot water and ignite in a porcelain crucible. Dissolve in HCl 1:1, add ammonia to precipitate iron, filter, wash, and again precipitate with ammonium oxalate. Filter, wash, dissolve in dilute H_2SO_4, add a drop of HCl, and titrate with $KMnO_4$. Nickel: To 25 cc of electrolyte add 10 cc strong HCl and 200 cc water. Precipitate with H_2S, filter, dissolve filtrate in HNO_3, evaporate to dryness, take up in 10 cc HCl and add 100 cc water. Precipitate with H_2S and filter, receiving filtrate in same beaker as at first. Add HNO_3 and evaporate to 200 cc. Precipitate the iron with ammonia, repeating the precipitation. Add acetic acid in slight excess, heat and precipitate with H_2S. Filter, wash, and ignite. Dissolve the precipitate in HNO_3, adding two drops H_2SO_4, evaporate carefully and weigh as $NiSO_4$. Arsenic: Take 10 cc and put in a 300 cc Jena flask, add 2 grams $FeSO_4$ and two small pieces of glass to prevent bumping. Fit the flask with a two-holed rubber cork through one of which passes a separating funnel and through the other a connection to a Liebig condenser. For heating the flask an electric hot plate is recommended. Run through the separating funnel 25 cc HCl, sp. gr. 1.20 and distill. Receive the distillate in a 500 cc beaker containing 20 cc water. Repeat distillation with 25 cc more acid. Neutralize the distillate with ammonia, make slightly acid with HCl, add sodium bicarbonate, cool, and titrate with a standard solution of I. Antimony: Add ammonia to 25 cc of the solution and precipitate with H_2S. Filter and wash. Add dilute H_2SO_4 to the filtrate to precipitate the sulpho-salts and let stand until clear in a warm place. Filter off the sulphides of arsenic and antimony through a small Hirsch funnel using asbestos. Transfer to a 200 cc beaker and add 20 cc HCl. Heat to just below boiling to remove H_2S. Cool and filter through asbestos, dilute to 200 cc, add tartaric acid, neutralize with ammonia, add HCl to acid reaction. then sodium bicarbonate and titrate with a standard solution of I. Bismuth: Precipitate 100 cc of electrolyte with ammonium carbonate, filter, wash, dissolve in dilute HCl, precipitate with H_2S, dissolve out the sulphides of antimony and arsenic with ammonium sulphide, filter, wash, dissolve in HNO_3, add ammonia and ammonium carbonate, filter, wash, dry and ignite and weigh as Bi_2O_3. Chlorine: Add nitric acid and silver nitrate to the electrolyte and filter out the silver chloride. Scorify the paper with test lead, cupel and weigh the silver. Total sulphuric acid is determined by acidifying with HCl and precipitating as $BaSO_4$.

Oxy-Acetylene Flame.

Welding and Cutting.—Cutting and welding by the use of the oxy-acetylene flame, which has been the subject of numerous articles in this journal, has recently been discussed in two papers, one read before the Technology Club, of Syracuse, by Eugene Bournonville, and published in *Iron Age*, November 26, the other an anonymous contribution to *Engineering News*, November 19. Three classes of burners are in use—high, medium and low-pressure burners. The high-pressure burner requires both gases to be used under pressure, and suitable valves must be inserted in the supply pipes to prevent one gas from forcing itself over into the other's tank. The usual pressures used in this type of apparatus vary between 125 lb. and 200 lb. per square inch. They allow of an absolute control of the gas mixture, but there is difficulty in providing the gases under the high pressures, the tips are likely to get hot and burn off, and finally great skill is required in their manipulation to prevent the blowing away of the metal as fast as melted. Particular attention is called to the dangers of the gases under high pressure; one usually overlooked is the lubrication of the oxygen compressor, most ordinary varieties of oil vaporizing and forming an explosive mixture in the tank. The best burner suitable for general work uses the gases under medium pressure

8 lb. to 15 lb. per square inch. Such burners when provided with an extra jet for conveying oxygen at high pressure just back of the flame are used for cutting purposes, the flame heating up the metal to the ignition temperature and the oxygen from the extra jet burning it out. With such a burner a steel bar 2 in. x 3½ in. was cut through in one minute; a 9-in. I-beam was cut through in two minutes; a 4-in. x 6-in. beam built up of 1-in. plates was cut through in six minutes after being brought to the starting temperature. The low-pressure burners require oxygen under pressure, the acetylene being drawn into the burner by an injector action. They lack control of the mixture. By the use of the oxy-acetylene torch it is possible to weld copper to iron and cast iron to steel, the weld in this later case showing a gradual transition from the one metal to the other.

Zinc.

Bright Electrolytic Deposits.—A method of obtaining bright deposits of zinc by electroplating is described by Carl Richter in *Electrochem. Zeit.*, and noticed in Lond. *Elec. Eng'ing*, Dec. 31. The bath employed is a modification of that of Pfannhauser, and consists of zinc sulphate and ammonium sulphate, but, whereas that of Pfannhauser is employed neutral, Richter adds small quantities of sulphuric acid; the amount, however, is extremely small, varying from 1/38 to 1/20 normal. The temperature of the bath was usually kept at that of the atmosphere, a current density of about 80 amperes per square decimeter (about 740 amperes per square foot) was employed, the e.m.f. being between 0.75 and 0.85 volt. Electrolytic zincing has so much in its favor, at any rate for small articles, and for articles which require to be bent about, owing to the extremely adhesive condition of the zinc, that given a method for depositing it in a bright form, it should rapidly come into use on a large scale. One of the objections to hot galvanizing is the large amount of spelter which requires to be kept in use, and the deterioration which takes place by alloying with the articles which are dipped, and the necessity to keep the bath molten means the consumption of a large amount of fuel.

ANALYSIS OF CURRENT ELECTROCHEMICAL PATENTS.

Electric Furnaces.

Electrode Construction for Furnaces.—Dr. P. L. T. Héroult has designed a stuffing box through which the electrode is fed into the furnace as its end burns away. The stuffing box is provided with a packing of conducting material through which the current is passed to the electrode. The packing is loose graphite in form of grains of varying sizes, so that the voids between the larger grains are filled by the smaller grains, and the entire mass makes a compact, dense medium for conveying the current to the electrode. The stuffing box is made of copper and water-cooled; it is enlarged toward its outer end so that the withdrawal of the electrode tends to loosen the packing. (908,407, Dec. 29, 1908.)

Carborundum.—For the production of carborundum, such a high temperature is required as is obtainable only in an electric furnace. But this does not mean that all the heat must be produced electrically. As the process is essentially discontinuous and the charge has first to be heated up to the temperature of reaction, Mr. F. J. Tone, superintendent of the Carborundum Company, proposes to use no electric heat for this lower temperature range, but to heat the charge up by means of gaseous products of combustion. These may be carried either around a cylinder containing the charge or through the charge, several constructions being described. When the charge has been preheated in this way the electric current is turned on and the production of carborundum starts. Naturally there is a considerable economy in preheating in this way in comparison with the expensive electric heat. (908,357, Dec. 29, 1908.)

Nickel from Silicious Ores.—Mr. E. F. Price, general manager of the Union Carbide Company, smelts a silicious ore of nickel and iron in an electric arc furnace to produce ferronickel. Sufficient carbon is used in the charge, not only to reduce the nickel and iron, but to protect the carbon electrodes from oxidation. Instead of the arc furnace, a resistance furnace may be employed for reduction. The resulting ferronickel is then treated to remove the iron by oxidation, by blowing air into the alloy. This may be done in the reduction furnace, which for this purpose is provided with tuyères at its lower end for the introduction of the air blast. The alloy is thus electrically heated and maintained in a molten condition by electric heat in addition to that supplied during reduction. Silica for slagging the oxidized iron may be derived from the charge or may be independently added. If the product of reduction contains silicon, the oxidation of this silicon supplies heat to maintain the metal in a molten condition, and the resulting silica combines with the iron oxide. A deoxidizer, such as silicon, ferrosilicon or aluminum, may be added to the high-nickel product before casting it into ingots. (909,666 and 909,667, Jan. 12, 1909.)

Silicon.—Dr. Henry Noel Potter, whose extended researches on silicon and silicon monoxide are well known, has recently been granted another patent in this line. It relates to the production of silicon free from silicon carbide. This patent contains many interesting points. If silica is reduced by carbon, the following three reactions take place simultaneously:

$$Si\,O_2 + 3\,C = Si\,C + 2\,CO.$$
$$Si\,O_2 + 2\,C = Si + 2\,CO.$$
$$Si\,O_2 + C = Si\,O + CO.$$

There are four principal reaction products, Si C, Si, Si O and CO, which separate according to their properties. Si dissolves some or all the Si C and the two flow down till they either freeze or find lodgment before solidifying. The Si O and CO pass off together, the Si O depositing in the gas vents through which C O escapes. The first of the above three reactions cannot be suppressed in any mixture yielding a sufficient quantity of silicon per kw-hour to be commercially efficient. The reason appears to be that fluid Si adheres firmly to Si C and dissolves at least a portion of it and then shields it from reaction with $Si\,O_2$. Increasing the silica in the mixture only facilitates the third of the above reactions. However, there is another reaction for the production of silicon, namely:

$$Si\,O_2 + 2\,Si\,C = 3\,Si + 2\,C\,O.$$

There is no carbon in the mixture and the starting material would be expensive, if crystalline carborundum, Si C, were used. But it is possible to employ "carborundum fire sand," a cheap crude by-product of the manufacture of carborundum. It contains a large amount of Si C, mostly in the amorphous state, also some free carbon and $Si\,O_2$, but varies in composition. It may also contain "siloxicon" (indefinite compounds of the formula $Si_x\,C_x\,O_y$). A sample analysis of carborundum fire sand is 70 per cent Si C, 17 Si O, 7 C and 6 slag. With this fire sand, together with silica and extra coke, a mixture can be made, $8\,Si\,O_2 + 6\,Si\,C + 4\,C$, or by weight 62.4 per cent $Si\,O_2$, 31.4 Si C, 6.2 C. This mixture treated in the electric furnace yields a large amount of Si per kw-hour (in an actual case over 50 grams of silicon per kw-hour), but this silicon must be purified and freed from any contained Si C in a second step.

The principle of the purification process is as follows: Fluid silicon does not dissolve carbon, but dissolves silicon carbide. Further, Si C and $Si\,O_2$ react readily beneath a bath of fluid silicon, the products being either Si or Si O, or both and C O; also Si C can react with Si O, the products being Si and C O. Hence if $Si\,O_2$ be present beneath a bath of fluid Si, then the $Si\,O_2$ and contained Si C can react, while any Si O liberated may react with Si C, so that the final products are Si, which adds itself to the silicon already present, and C O, which escapes. The temperature is sufficient to cause a bed of granular quartz sand to fuse into a vitreous mass of sufficient sustaining power to support the fused silicon in a hollow formed in the silicon

bed. A very satisfactory arrangement is to use an electric arc furnace with vertical co-axial electrodes, the lower surrounded near the arc by a bed of silica upon which, surrounding the arc and upper electrode, is a mixture of the composition $8\,SiO_2 + 6\,SiC + 4\,C$. The mixture upon the bed must be deep enough to prevent the furnace blowing, which occurs when the escaping CO gas opens a large vent through which it escapes, carrying SiO, SiO_2 and Si as dust or vapors with it. If the CO escapes through a porous mass of crushed carbon, for example, it is cooled enough to issue alone. It is an advantage to have both electrodes movable, and it is also an advantage to operate a long arc at about 150 volts or more, rather than at 100 volts. The specification contains some further details of operation. (908,130, Dec. 29, 1908.)

Sodium Peroxide.—"Oxone" or fused sodium peroxide is made, according to Mr. D. E. Parker, as follows from powdered peroxide: The powdered peroxide is heated electrically in a ladle with the aid of two electrodes dipping into it. The action is started by means of a temporary removable electric resistance; when the peroxide is molten, it is a conductor and then forms itself the resistor. The temperature is kept between 710° and 718°. The melting pot is then tipped and the fused peroxide is run into water-cooled molds. (909,017, Jan. 5, 1909.)

Electrolytic Processes.

Chlorine and Caustic by Mercury-Cathode Process.—Two patents of Mr. C. F. Carrier, Jr., refer to details of the mercury-cathode cell. One has to do with the method of circulating the mercury continuously between the electrolyzing and oxidizing compartments. The electrolyzing compartment is in the center, the oxidizing compartment is arranged in circular ring form around the former and separated from it by a circular wall. The bottom of the electrolyzing compartment has an opening in the bottom from which conduits lead to the outer oxidizing compartment. These conduits are filled with mercury and the opening in the bottom of the electrolyzing cell contains a centrifugal pump which provides the circulation of the mercury. This pump is made of earthenware and its rotor has a relatively slow movement, while the mercury conduits have a relatively large cross section, in order to procure a quiet and uniform flow of the mercury. Like the casing and rotor of the pump, the mercury conduits are made of earthenware. This is important in order not to contaminate the mercury. (908,546, Jan. 5, 1909.)

A second patent of Mr. Carrier refers to the decomposing cell in which the sodium amalgam gives off its sodium, to form caustic soda. It is known that this reaction is accelerated by local action. Mr. Carrier uses for this purpose graphite bars extending above the surface of the amalgam to a sufficient height to permit a substantial difference in the density of the caustic soda solution in contact with the bars. This height is preferably not less than 2 inches. (908,545, Jan. 5, 1909.)

Chlorine and Caustic by Diaphragm Process.—Mr. Marcus Ruthenburg uses a diaphragm cell of circular form containing a porous cup. The anode compartment is inside and closed, the chlorine gas being drawn off through a tube in the top. The cathode compartment is outside of the porous cup and open to the atmosphere. The cathode is a cylinder of wire cloth, formed of volute layers encircling the local porous cup. A number of such cells are connected in a series and the cathode compartment of each cell is connected with the cathode compartment of the next cell by means of a pipe leading from the bottom of the former to the top of the next cell. The scheme is to deliver the lower concentrated portion of the sodium hydrate solution in the cathode chamber of each cell to the cathode chamber of the next, and so on through the series, in order to get a gradually increasing concentration along the series. (898,785, Sept. 15, 1908.)

Plating Chains and Rolls.—Two patents were recently granted jointly to Mr. Abraham Van Winkle, the distinguished pioneer of the electroplating industry in this country, and Mr. John T. Daniels. Both patents refer chiefly to the mechanical arrangement and are distinguished by effective simplicity of design. The first patent refers to the plating of heavy chains, arranged in the form of continuous loops moving upon and about conveying rolls or drums. The chain is suspended from a revoluble roll above the plating tank and is in rolling engagement with it so as to be moved continually through the plating solution. At the same time the chain moves along a revolving brush so as to produce a bright or burnished electrodeposited surface. (907,425, Dec. 22, 1908.)

The other patent refers to the plating of tubes, pipes, etc. The apparatus comprises one or more contact-producing and supporting rolls, upon which are arranged metallic chains, forming good electric conductors. In the loops are deposited, in rolling relation with each other, piles of tubes, pipes, rods, etc., to be plated. (907,426, Dec. 22, 1908.)

Removal of Metallic Plating.—A process for removing copper, nickel and zinc coatings from metallic surfaces is patented by Messrs. T. R. Bayliss, W. R. Hodgkinson, J. H. Hardcastle, A. H. Coote and R. A. E. Payne. The process is especially useful for the removal of the metallic fouling from the "lands" or "grooves" of the bore of a breech-loading gun. The process consists simply in using the surface to be stripped as anode in an electrolyte containing 2 per cent by volume of glacial acetic acid, 15 ammonia (0.88 specific gravity), and 83 water. (908,937, Jan. 5, 1909.)

Discharges Through Gases

Ozone.—Mr. W. Koelle has modified the Elworthy ozonizer, which consists of dielectric tubes with inner and outer conductors out of contact with the dielectric tubes. Electric discharges take place between the conductors and the adjacent walls of the dielectric and the air is ozonized by passing first through the interior of the tube and then over the outside. In Koelle's modification a number of tubes are arranged concentrically with coils supported at a short distance from the walls, so that the outer coil on one tube forms the inner conductor for the dielectric tube of the next larger diameter surrounding the first tube.

RECENT METALLURGICAL PATENTS.

Iron and Steel.

Removal of Sulphur from Steel in the Electric Furnace.—The reactions and processes by which sulphur is removed from steel in the electric furnace were discussed at length in three papers by Geilenkirchen, Osann, and Harden in our October issue, 1908 (Vol. VI, p. 405). With reference to these papers, the following note from London *Electrical Engineering*, Dec. 17, is of interest. The reduction of sulphur in the electric furnace depends on its combination with calcium, and not, as in the case in other metallurgical processes, with manganese. The desired conversion of iron sulphide and of manganese sulphide (in the steel bath) into calcium sulphide (in the slag) can only take place in presence of a powerful reducing agent. In the Héroult electric furnace calcium carbide is employed to remove the sulphur, while in the induction furnaces ferrosilicon is used. The desulphurizing power is practically the same in both cases, but the use of ferrosilicon is more expensive. In the Héroult process the calcium carbide is made in situ by the action of the carbon electrodes on the lime slag. It does not, therefore, require to be first made and then added to the furnace charge, consequently it is found to be about $1.25 cheaper per ton of iron smelted than if ferrosilicon were employed. There is also a danger in the use of ferrosilicon that the finished steel may contain too large a quantity of silicon. The employment of calcium carbide to produce a slag poor in metal has been patented by the Elektrostahl-Gesellschaft, German patent 163,519.

Alloy.—J. F. Clapp patents an iron alloy or steel, "characterized by great hardness, toughness, tensile strength and resistance to corrosion." It comprises from 40 to 90 per cent

iron, 1 to 30 iridium, and 0.2 to 10 platinum. To facilitate the uniform solution of the iridium and platinum in the iron, prevent segregation upon cooling, and produce a homogeneous, fine-grained product, it is "desirable" to add to the alloy molybdenum (1 to 15 per cent) and "preferably" copper (0.5 to 15) and nickel (0.5 to 15). (909,283, Jan. 12, 1909.)

Lead.

Treatment of Slimes of Refineries.—It is well known that in the development of the Betts process for the electrolytic refining of lead—which is now used successfully at several places—nothing has offered greater difficulties than the treatment of the slimes. At the pioneer Betts refinery in Trail, British Columbia, Mr. Alexander J. McNab has worked out the following process: The slime is first treated with sodium polysulphide, which dissolves antimony, arsenic, tellurium, and selenium. The solution is filtered off and the antimony recovered by electrolysis, the sodium sulphide solution being regenerated. When too much arsenic accumulates in the bath it is removed by evaporation to 35° B. and subsequent cooling. The residue resulting from the treatment of the slime with the sodium polysulphide contains silver (both metallic and as sulphide), lead, bismuth, copper and gold. This is roasted to convert the sulphides into sulphates. By treatment with water or dilute sulphuric acid, the copper sulphate, most of the silver sulphate, and some of the bismuth sulphate is dissolved. This solution is separated from the residue, which consists mostly of metallic gold and silver, lead sulphate, and basic bismuth sulphate. The silver and bismuth is precipitated by copper, and the precipitated metals are melted down in a reverberatory furnace, the bismuth being oxidized off and recovered as oxide, which can be further treated by known methods to convert it into metallic bismuth, bismuth oxychloride, etc. The filtrate resulting from the precipitation of silver and bismuth is concentrated and allowed to stand to crystallize the copper sulphate resulting from the treatment of the original solution with copper, and to recover the free sulphuric acid, which is to be used over again. The residue of metallic gold and silver, lead sulphate and basic bismuth sulphate is charged into a reverberatory furnace, the lead and bismuth oxidized off, and the bismuth recovered. The gold-silver alloy is then parted by well-known methods. (908,603, Jan. 5, 1909.)

Separation of Lead from Zinc.—To separate lead from zinc vapor, E. H. Shortman uses an intercepting medium, consisting of small pieces of coal or coke, preferably anthracite. The anthracite is placed in the end sleeve of the receiver for the purified zinc. This end sleeve of the receiver extends into the interior of the retort, so that the whole vapor must pass through the anthracite. (905,753, Dec. 1, 1908.)

Copper.

Copper-Titanium for Copper Castings.—It is well known that copper, when melting, absorbs gases and is oxidized, to an extent, during fusion, the resulting oxides dissolving in the metal with the result that copper cannot be cast in sand directly from crucibles, or in sand molds made in flasks, or such molds as are used for casting pig iron. Copper cast in this way contains blow holes and cavities to a prohibitive extent. Mr. Auguste J. Rossi, the indefatigable pioneer of titanium (who is now about to see the fulfillment of his life's work, the permanent establishment of a titanium industry), recommends the addition to the copper of from 1 to 2 per cent in weight of combined cupric and titanic materials; for example, an alloy of copper and titanium containing from 5 to 12 per cent of titanium. This alloy is used to the extent of 1 to 2 per cent of the entire weight of copper. The titanium binds the gases, etc. Copper treated in this way can be cast in sand in flasks such as mentioned above, the pouring being quiet, without overflow through the gates, and without piping, and the resulting bars, solid, presenting in practice a close grained, dense structure, free from blow holes.

Aluminothermics.

Substitutes for Aluminium.—In our Vol. VI, p. 360, we printed a paper by Dr. Hans Goldschmidt, describing in detail his experiments on substituting a calcium-silicon alloy or a magnesium-silicon alloy or an aluminium-calcium alloy for aluminium in the aluminothermic reaction. The use of calcium-silicon is now covered by Dr. Goldschmidt's patent, 906,009, Dec. 8, 1908. While the applicability of these alloys is certainly very interesting from a scientific standpoint, the recent drop in the market price of aluminium renders it highly improbable that the alloys will soon supplant aluminium in the industrial applications of the thermit reaction.

Reduction of Pure Metals.—Mr. George O. Seward and Mr. F. von Kuegelgen have also endeavored to find a substitute for aluminium as reducing agent for the production of pure metals. They have found that alloys of the alkali-earth metals (barium, strontium or calcium, either single or combined), with suitable proportions of either aluminium, magnesium, zinc, etc., form brittle alloys which are easily crushed and form a very effective reducing agent. For instance, for the production of chromium from chromium oxide they propose to use calcium magnesium as reducing agent, or for the production of German silver from nickel oxide and cupric oxide they use a calcium-zinc alloy. (908,154, Dec. 29.)

Welding.

Autogenous Welding of Cast Iron.—It is unnecessary to emphasize the difficulties experienced in any attempt to weld two pieces of cast iron together. Mr. A. Beltzer and Mr. C. Delcampe claim to have solved the problem by means of a flux, consisting of 65 per cent potassium chloride, 15 per cent lithium chloride and 20 per cent potassium fluoride. One particular advantage of their process is that it is unnecessary to clean the surfaces to be welded. They proceed as follows: They preheat the surfaces to be welded, sprinkle them with the flux powder, and then heat the surfaces to substantially the melting point. "It is preferred during this heating operation to add cast iron to the joint, and for this purpose a rod or pencil of cast iron is dipped in the flux and presented to the heating flame, where it is melted and flowed onto the joint, much in the same manner that solder is applied to a joint in soldering pieces of tin together, except, of course, that being cast iron, the cooling process is so much faster that each portion of the joint must be finished as the heat is advanced along it. The addition of the flux to the cast-iron rod, which is melted on a joint, is for the purpose of refining the cast iron as it is applied to the joint, so that it will form a union with the pieces of cast iron to be welded, and also to bring some flux into the molten metal of the pieces to be welded.

"Blow holes may be filled by the addition of cast iron in the above-described manner, so also errors in workmanship may be cured by adding cast iron to surfaces where too much has been removed, or, again, a protuberance may be formed by adding cast iron at any particular place where it is desired. A valuable feature of the invention consists in this, that when such cast iron is added to an original casting or piece the added portion and its joint with the original iron are stronger than the original casting." The inventors state themselves that "the invention is based upon principles which are not fully understood," but they believe in a general way that "the operation is based upon the affinity of the halogenides and the halogenide acids for the impurities of the cast iron."

Welding Copper.—For welding copper Mr. James Crew patents a composition consisting of the following ingredients, viz.: 10 parts borax, 8 parts carbonate of iron, 3 parts alum. These ingredients are thoroughly mixed together and a suitable amount of the mixture is placed on the joints or ends of the copper intended to be welded; after first heating the copper to a sufficient heat, the joint is hammered together as in welding iron. (906,202, Dec. 8, 1908.)

Exhibition of Chemical Engineering Apparatus and Machinery.

A special feature of the Pittsburgh meeting of the American Institute of Chemical Engineers, on Dec. 28 and 29, was an exhibition of various apparatus, machinery and appliances of interest to chemical engineers. This exhibition had been arranged in the basement of the Carnegie Technical Schools and attracted a great deal of attention.

Pyrometers.

The **Leeds & Northrup Company** of Philadelphia had an exhibit of two of their latest designs of pyrometers, in charge of Mr. C. R. Cary. Dr. E. F. Northrup, who himself attended the meeting, read a paper on modern resistance pyrometry, which is given in abstract on page 62 of this issue.

One of the pyrometers exhibited was the indicating self-checking instrument which was described and illustrated in our January issue, page 44.

The second pyrometer exhibited was an entirely novel type of recording instrument. The recorder is primarily designed to give a continuous record of temperature changes, but as the movements of the recording pen can be made to respond to changes in electromotive force or changes in electrical resistance, it is obvious that the instrument may be made to record many other quantities than temperature. The instrument

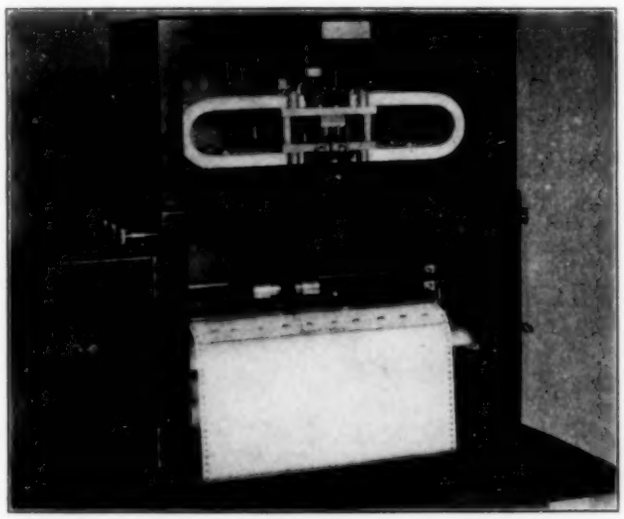


FIG. 1. RECORDING PYROMETER.

consists essentially of three parts: (1) A large and robust differential galvanometer which carries on its moving part a small piece of platinum rod. Attached to the galvanometer frame is a small plunger magnet which at two-second intervals causes the above piece of platinum to make contact if the galvanometer is off balance with a piece of silver on the right-hand side of the small ivory strip or with a piece of silver on the left-hand side of this ivory strip. If the galvanometer is balanced, the piece of platinum is brought into contact with the ivory strip and no electrical contact is made. (2) A Seth Thomas clock, which performs the double function of advancing the paper at any desired speed within wide limits, the standard speed adopted being three inches an hour, and to make at two-second intervals a contact which operates the small plunger magnet which causes the above piece of platinum to make contact. (3) The record portion, which consists of a paper drive and apron over which the paper travels and a stylographic pen used to trace a line upon this paper. The same mechanism that advances the pen also moves a sliding contact over a spiral of resistance wire.

The recorder has been designed to give the record on a continuous strip or sheet of cross-section paper, ruled in rectilinear coordinates. The movements of the recording pen are strictly proportional to the temperature changes being measured. This recorder would be most commonly used in the measurement of temperature with a resistance type of thermometer or pyrometer. While it is well known that the temperature coefficient of platinum or other wire used for pyrometers is not a linear function of the temperature, the recorder nevertheless gives a record which is proportional to temperature changes, even though the resistance changes in the pyrometer are not proportional to the temperature.

This instrument is susceptible of great sensibility. The portion of the record shown on which the record is traced is 10 in. wide and this 10-in. interval may correspond to as little as 4 deg. C., while the movements of the pen will respond in this case to temperature variations of 0.02 of a degree Centigrade, thus giving a record of temperature to an accuracy of ½ per cent when the temperature interval being measured is only 4 deg.

When the temperature interval being measured is 100 deg. or more, the instrument can be made to record to an accuracy of ¼ per cent of the temperature interval being measured, without alteration in any of the mechanical features of the instrument.

The temperature range can be varied through very wide limits by simply changing a shunt resistance and the same instrument may be made to give a temperature record from 800 deg. to 1000 deg. or 600 deg. to 800 deg. by simply changing the fixed resistance. All parts of the apparatus are easily removable as separate units, and all the separate units into which the apparatus may be separated are entirely interchangeable so that if any part should fail to operate this part may be quickly replaced by a new part.

The apparatus being exhibited at Pittsburgh was recording the variations in the temperature of an electric oven produced by varying the current through this oven in a range of 500 deg. C. to 1000 deg. C. The features of the apparatus are on principles not heretofore used in either the measurement or the recording of temperatures.

* * *

Chemical Stoneware.

The **Didier-March Company** of New York had quite a large and interesting exhibit, which was in charge of Mr. G. S. Hessenbruck, contracting engineer of the company. This firm devotes one entire plant to the manufacture of acid-proof chemical ware. This chemical ware is identically the same grade and class of material as is imported from Germany. They manufacture all of their various products at their works at Keasbey, N. J., using, however, imported raw material. It is a great advantage that this class of material is now being made in this country.

Their exhibit, though not showing their whole line of manufacture, comprised the following articles: Tourills, system cellarius, suction filters, injectors, acid-proof centrifugal pump, and various kinds of bib and flanged cocks of various diameters.

The article which attracted particular attention was the so-called cellarius cell shown in Fig. 2 on page 90. This cell is a vessel resembling in cross-section a semi-circular arch, with a very large surface in proportion to the quantity of liquid it contains, the arrangement being such that the entire surface can be cooled. The cell is mostly used in modern hydrochloric acid plants, and is so efficient that by good cooling an acid can be directly obtained of a strength of 24 deg. Bè. The absorbing liquid enters through an inlet on the front side of the tourill, travels to the end and crosses the saddle in a broad stream, and then flows along the other side before it escapes through the outlet on the front side. It, therefore, travels twice the whole length of the vessel, always being cooled by contact with the bottom of the cell, which is immersed in water.

An acid pump exhibited was an ordinary centrifugal pump, having, however, a stoneware lining and stoneware impeller, so that it is suitable for the handling of any kind of acid without

any danger of the acid affecting or destroying any of its parts.

The various kinds of cocks that were shown were admired for their smoothness and evenness of grinding, and the sizes of these cocks varied all the way from 5/8-in. to 2½-in. inside diameter.

The Didier-March Company also exhibited a number of plans of various processes for which the company has the sole right of manufacture in this country. Among them were plans

FIG. 2.—CELLARIUS CELL.

and elevations for bromine refining apparatus, nitric acid condensing plant, denitrating plant for spent acid, regenerating plant, storage plant for storing 33 tons of acid, continuous bromine refining plant, nitric acid plant system Valentiner, hydrochloric acid condensing plant.

* * *

Pulverizing Mill.

The **Fuller Engineering Company** of Allentown, Pa., had an interesting exhibit, which centered on the Fuller-Lehigh pulverizing mill. The Fuller mill is extensively used by cement manufacturers, and in order to show the simplicity of arrangement of a Portland cement plant equipped with Fuller mills complete plans of the Seaboard Portland Cement Company and the Allentown Portland Cement Company were shown. Supplementing this was a complete model of the Fuller mill, which showed in detail the construction and operation of the machine.

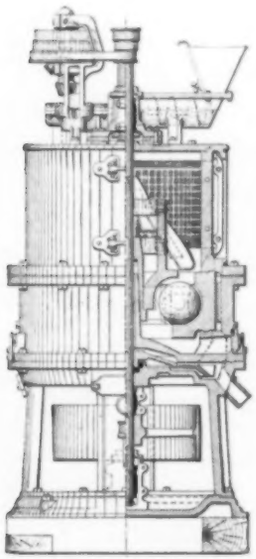


FIG. 3.—FULLER MILL.

That the machine is not confined to the cement industry alone was evidenced by a variety of materials shown in sample jars; all these materials were pulverized by Fuller mills, and among them may be mentioned talc, coal, coke, charcoal, chrome ore, iron ore, blast furnace slag, puddlers' slag, quartz, barytes, fluorspar, silica, caustic lime and phosphate rock, and even such exceedingly hard material as titanium carbide.

The Fuller mill is made in two sizes, 33 in. and 42 in., these being the diameters of the dies used in the respective machines. The material to be reduced is fed to the mill from an overhead bin by means of a feeder mounted on top of the mill. This feeder is driven direct from the mill shaft by means of a belt running on a pair of three-step cones, which permits the operator to accommodate the amount of material entering the mill to the nature of the material being pulverized.

The grinding is done by means of four unattached steel balls, which are propelled by four equidistant horizontal arms or pushers radiating from a vertical central shaft. The material discharged by the feeder falls between the balls and the die and is reduced to a finished product in one operation.

Above the die and the balls is a fan which is attached to the yoke propelling the balls. This fan has two rows of fan blades, one above the other. The lower set of fan blades lifts the finished product from the pulverizing zone into the chamber above the die, where it is held in suspension until it is floated out through a screen by means of the fanning action of the upper row of fan blades. The finished product is then discharged through a spout, which may be placed at any one of four quarters of the mill.

The balls of the 33-in. mill are 9¼ in. in diameter, weigh about 118 lb. each and are propelled at a speed of from 200 to 210 revolutions per minute. The balls of the 42-in. mill are 12 in. in diameter, weigh about 260 lb. each and are propelled at a speed of from 150 to 160 revolutions per minute. The mill is driven by belt, as shown in the adjoining figure, or may be driven by a motor coupled direct to the shaft.

The only parts subject to wear are those parts which come in direct contact with the material being pulverized, and, as the entire pulverizing action takes place in a limited zone, the wear and tear is reduced to a minimum.

The Fuller mill is self-contained and requires no accessory equipment. It is shipped assembled complete and is ready for operation as soon as placed on the foundation. Inasmuch as neither the 33-in. or 42-in. mill requires a greater floor space than 7 ft. square, the cost of installation is reduced to a minimum. The material delivered by the mill is a finished product and requires no subsequent screening. Power cost and maintenance cost are low. The exhibit of the Fuller Engineering Co. was in charge of Mr. Hachtman.

* * *

Welding and Cutting by the Oxy-Acetylene Flame.

The exhibit of the **Davis-Bournonville Co.**, of New York City, was in charge of Mr. Henry Cave, president of the Autogenous Welding Equipment Co., of Springfield, Mass., representing the former company in the New England States. The exhibit comprised oxy-acetylene cutting and welding torches and various samples of welds and cuttings made in this way.

As we have explained in numerous former articles on this subject, the burner for welding has simply two supply pipes, one for acetylene, the other for oxygen gas, and a temperature is thereby produced considerably higher than that of the oxy-hydrogen flame. The burner for cutting is like the burner for welding, but has an additional supply pipe for oxygen gas; its action is in two steps—first, the parts to be cut are highly preheated by the ordinary oxy-acetylene flame; then the current

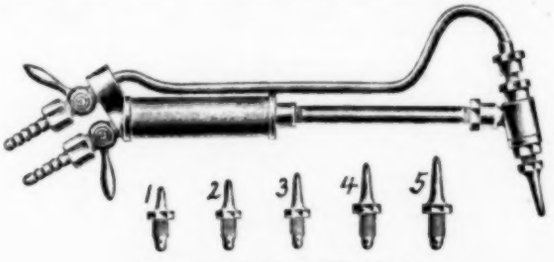


FIG. 4.—OXY-ACETYLENE TORCH.

of oxygen gas from the additional supply pipe produces spontaneous combustion of the metal. (See, for further details, M. U. Schoop, this journal, 1907, Vol. V, page 308.)

The equipment, therefore, comprises an acetylene pressure generator, an oxygen generator, oxygen cylinders, an acetylene regulating valve, an oxygen reducing valve, gauges, etc., and high-pressure torches (Fig. 4). The torches were exhibited in two sizes, each having five interchangeable tips and the necessary high-pressure hose for supplying them with gas.

The gases pass from the hose into the torch and thence into the tip, the oxygen passing in through a small hole in the center of the inner end of the tip, while the acetylene enters at the side, striking the oxygen current at a right angle. This provides a very intimate mixture, which only requires a volume

of oxygen 1.28 times that of acetylene to give complete combustion, resulting in a neutral flame having a temperature of from 6000 to 7000° Fahr.

The holes in the inner end of the tip regulate the flow of the gases so that the proportions of the mixture are constant under all conditions. No outside influence, such as a particle of metal adhering to the tip, can make the flame either oxidizing or carbonizing, as would be the case if the torch worked on the injector principle.

For convenience acetylene dissolved in acetone was used in the demonstration instead of the pressure generator. The oxygen was used in compressed form in a cylinder. Mr. Cave welded numerous samples of cast iron, steel and aluminium and also welded cast iron and copper to steel, one of the interesting features being the softness of cast iron after being treated in this manner.

A steel plate was also cut very readily with a jet of oxygen, applied from a cutting jet (additional oxygen jet) attached to the large welding torch. A corner of the metal was first brought to red heat by the oxy-acetylene flame, and then the metal was cut by oxidizing it away with the additional oxygen jet. After the cutting of a portion of the metal has been started the heat of combustion brings the portion to be cut afterward to a sufficiently high temperature to make the application of the cutting oxygen jet directly effective.

The intense heat of the oxy-hydrogen flame was very impressively demonstrated by applying it to the corner of a fire brick which melted and began to flow in two or three seconds. An interesting sample of cast iron welding, which was exhibited, is illustrated in Fig. 5. It shows a motor-cycle combustion head, having had part of the flange welded in and metal added to strengthen the exhaust part, thus saving the necessity of a new pattern and casting.

A pressed steel globe valve was also shown, the parts having been welded up by this process. In this way a perfectly reliable valve was obtained, the thickness and strength of the parts being known, which is not the case with the common cast valve, this making it very suitable for high-pressure work.

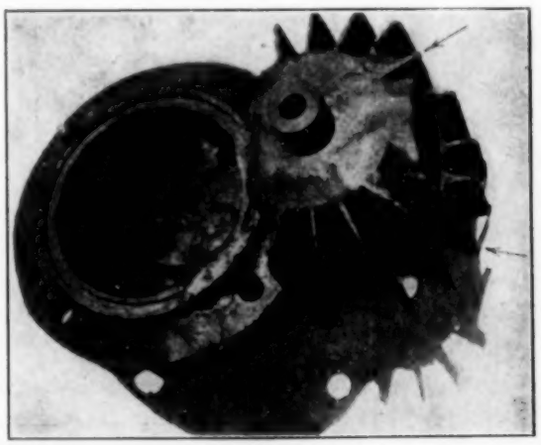


FIG. 5.—OXY-ACETYLENE WELD.

A sample was shown of sheet steel, nickel plated and welded up along the seams; this weld clearly showed the non-oxidizing nature of the flame by the fact that the nickel flowed over the weld, replating it automatically. This method of welding is now used for welding the seams of the containers of the Edison nickel-iron battery.

Another interesting specimen which demonstrated the localization of the heat consisted of a number of catalogues with holes punched in them, through which steel rings were inserted, the joints of the rings being welded without even scorching the paper.

Valve for Corrosion Liquids.

The **Cleveland Bronze and Brass Works** of Cleveland, Ohio, had an interesting exhibit of their acimet valve for corrosive liquids, in charge of Mr. Wm. H. Bloom.

Fig. 6 gives an external view of the globe pattern of the acimet valve, while Fig. 7 is a sectional view, showing the interior construction with the reinforced disc and seat.

The chief features are the use of "acimet" metal, a special lead alloy which eliminates any chance of corrosion, and the reinforcement of the acimet metal by means of a bronze structure which gives the required mechanical strength to withstand heavy pressure. These two features make the acimet valve of greatest usefulness in many industries where acids are either made or used in large quantities, as the employment of this valve does away with the familiar troublesome necessity of reseating and repairing at frequent intervals.

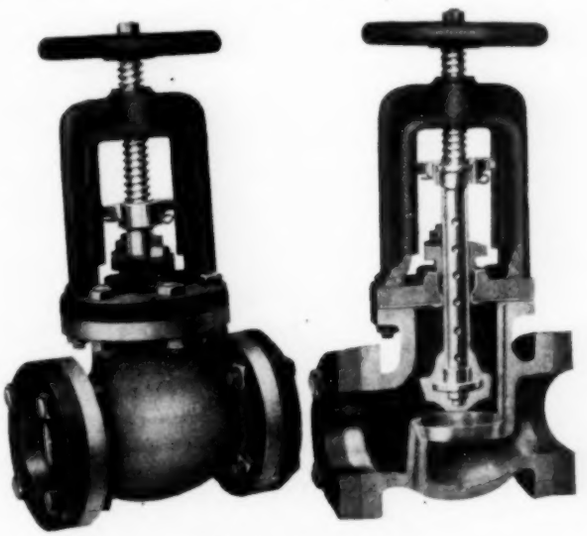


FIG. 6.—OUTSIDE VIEW.

FIG. 7.—SECTION ACIMET VALVE.

The body of the acimet valve is made of the special acimet metal reinforced, as shown in Fig. 7. A bronze ring is cast in the center and supported as shown, entirely surrounded with acimet metal, making a strong, rigid support. The yoke is made of cast iron, the stuffing box and the flange of the same being lined with acimet metal in the same way as the body. The screw is made of bronze with a four-pitch thread, making it quick opening. The valve stem is so constructed that it will not turn, similar to the loose disc valves, so as to do away with constant friction and to give a much longer life. Seating in the same place, entirely eliminating friction, there is very little wear; this, of course, also prolongs the life of the valve.

The connecting flanges are made of cast iron. Bolts are furnished with all flanges. Threaded flanges can be furnished also for iron pipe lines.

* * *

Evaporators.

The **George M. Newhall Engineering Company, Ltd.**, of Philadelphia, exhibited drawings of three principal types of exaporators built by them. They are shown in Figs. 8, 9 and 10.

Fig. 8 shows the salt evaporator used for all precipitation work, including that of salt brine, caustic brine, sodium carbonate and bichromate. It is built of flange boiler steel with cast-iron steam boxes and wrought-iron vapor pipes. This is the most economical construction in the precipitating evaporator, containing the least amount of metal per square foot of heating surface.

Fig. 9 shows the concentrating evaporator, used for all classes of foamy liquors, including sodium carbonate, caustic soda,

black liquor (soda pulp mill), sodium phosphate, and certain extracts. This is built of flange boiler steel and the heating surface is placed according to the nature of the liquor to be concentrated in such a way as to get the maximum and most efficient circulation. The steam boxes are made of cast iron, and the vapor pipes of wrought iron.

The Newhall Engineering Company have designed a modi-

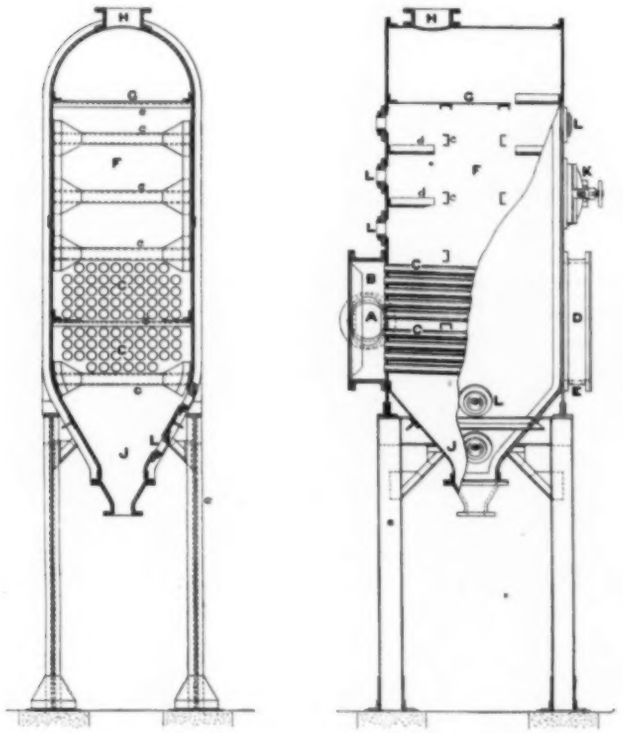


FIG. 8.—SALT EVAPORATOR.

fication of this type which consists in a flange-steel evaporator with a lead lining, homogeneously welded to the steel. This is designed to meet the needs of manufacturing chemists wishing to concentrate acid liquors in large quantities in multiple effect, either for the purpose of economizing steam or using exhaust steam.

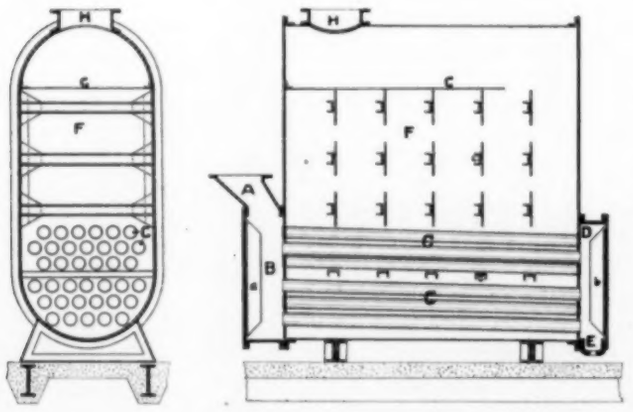


FIG. 9.—FOAMY LIQUOR EVAPORATOR.

Fig. 10 shows the sugar evaporator which is used on all grades of cane and bet juices. It has two shallow liquor levels, so that the amount of juice in transit is a minimum and no discoloration or inversion is caused. This has the added advantage of large capacity for machines of given size. It is built of either cast iron or boiler steel. The steam boxes are of cast iron or cast steel, the vapor pipes are of wrought iron or boiler steel.

In all three diagrams *A* represents the steam inlet and *C* are the heating tubes.

Referring to Fig. 8, showing the salt evaporator, *F* is the vapor space over the boiling solution, *G* a baffle plate, and *H* the vapor nozzle. *C* are channels bracing the side walls.

In Fig. 10, *A* is again the steam nozzle, *B* and *D* the front and rear steam boxes, *a* and *b* are channels bracing the steam box covers.

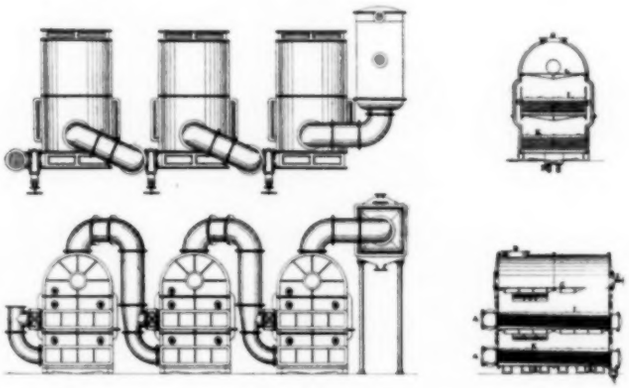


FIG. 10.—SUGAR EVAPORATOR.

Otherwise the three diagrams are self-explanatory. These three types of evaporators are believed to be adaptable to almost any evaporator problem that may arise.

The **Zaremba Company** of Chicago also had a fine and very instructive exhibit, in charge of their chief engineer, Mr. Otto Mantius. It comprised a model of Mr. Edw. Zaremba's patent evaporator and also a set of drawings showing types of some of their various evaporating systems. An illustrated description of the same must be reserved for a later issue.

Shaking Device for Laboratory.

The **Scientific Materials Company** of Pittsburg exhibited in operation the motor-driven shaking device for the chemical laboratory, which is an invention of Mr. J. M. Camp, chief chemist of the Carnegie Steel Company at Duquesne, Pa. This shaking device was fully described and illustrated in our Vol. V, p. 270.

Enameled Pipe.

The enameled pipe now being placed upon the market by the Enameled Pipe & Engineering Company, of Cleveland, Ohio, has proven to be absolutely rustproof, acidproof and alkaliproof and is being used successfully in mines, paper mills, chemical works, pulp mills, reduction works, chemical laboratories, oil wells, oil pipe lines and similar places, where the acid or alkaline conditions of liquids or gases would cause the rapid deterioration of any metallic pipe.

Another valuable feature of this enameled pipe is that it is not subject to electrolysis, so that electric currents do not affect it in the slightest degree. The Enameled Pipe & Engineering Company also guarantees their pipe to stand any pressure that standard steel pipe will stand.

In the process of manufacture the steel pipe is provided both inside and outside with a coating of hard vitreous enamel, which in some ways has the consistency of glass, but it is much harder, more flexible and tougher and is absolutely proof against the action of acids or alkalies. This enamel is not a paint and does not have in its makeup any japan, resin or coal tar products. The enamel will not come off, craze or scale from any cause unless it is hit with a sledge, and the pipe need not be handled any more carefully than sewer pipe.

The fittings for the enameled pipe are made heavy to with-

stand high heads, are coated with the same enamel as the pipe and are manufactured so as to produce all the results that common pipe fittings will produce. The company manufactures a full line of couplings, reducing couplings, elbows, forty-fives, crosses, tees, etc. These fittings have been tested to stand a pressure of 500 lb., and where the conditions demand it they can be furnished to stand higher pressures.

There are no threads in the fittings or pipe, and if properly installed there will be no break in the enamel in any way, thus producing a system of piping in which the liquid or gas cannot come in contact with any metal whatever.

The fittings used are very simple and are more easily attached, requiring less skill to install than common pipe fittings.

Enameled pipe is furnished in one-half the random mill lengths of common steel pipe. On special order extra strong and double extra strong pipe for high pressures can be furnished.

The packing furnished with the fittings is molded expressly for this pipe, and no cutting or trimming is required. Unless otherwise ordered, the packing is made of a specially prepared and compounded rubber, which has been found to resist the action of acids and chemicals better than any other compound experimented with.

The entire system of piping when installed is absolutely indestructible from the action of any chemicals attacking the pipe from either side, as both sides of the pipe and both sides of the fittings are thoroughly coated with the enamel, which prevents any chemicals from attacking or decomposing any metal contained in the piping system. The only exception are the bolts with which the couplings are put together, and these bolts are furnished, made of any metal that the purchaser desires.

Enameled pipe is furnished in all sizes from 2 in. and up in the standard sizes of pipe. The Enamel Pipe & Engineering Company maintains a corps of experts and engineers to assist its customers on any of the engineering problems which may confront them in connection with piping work.

Samples of this pipe have been tested in some of the largest copper mines of the West and coal mines of the East in the following way: Part of the piping system was made of this enameled pipe, while the rest of the pipe was left bare. The result was that in some cases within 33 days the entire unprotected portion was eaten up by the action of the mine water, due to the acid contained in it, while the enameled portion of the pipe remained absolutely perfect.

Dry Blast.

In our December issue (Vol. VI, p. 509) we noticed a recent patent of Mr. Louis Block, consulting engineer of New York City, for a method of drying the air for blast furnaces and converters. It will be interesting to describe here the manner in which Mr. Block proposes to carry out his method in practice.

In the adjoining diagram, which shows the arrangement, *A* is the blowing cylinder; *B* is the condenser and heat exchanger combined; *C* is the expansion cylinder, driving air compressors, pumps or other machinery. The trap to take away the water precipitated on the tube surfaces in *B* is also shown.

The pressure of air delivered to the furnace is assumed to be 17 pounds per square inch.

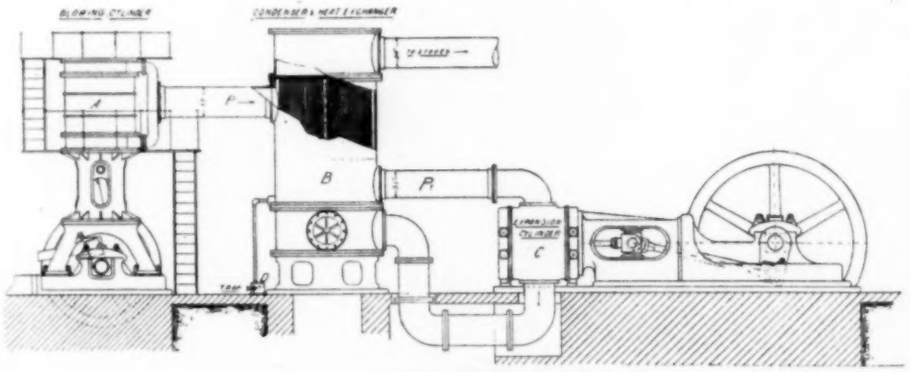
The beginning of operation will then be as follows:

The air is compressed in *A* to 25 pounds; it flows through pipe *P* into condenser *B;* leaves then *B* through *P'* and is admitted to the expansion cylinder still under 25 pounds pressure. The air is cut off by hand-adjustable Corliss valves exactly in the same way as in a steam cylinder and the air expands down to furnace tension, 17 pounds per square inch, and exhausts at this pressure, and at a temperature 45 deg. lower than it entered into the tubes of heat exchanger *B*, cooling the hot air delivered by the blowing engine into the space surrounding the tubes, while it warms itself and passes on to the stoves.

The cumulative effect of the cooling action is as follows:

The air leaving the blowing engine has a temperature of 235 deg. Fahr. It travels through *B* into *C*, is expanded down to 17 lb. while doing work, and is reduced to 190 deg., at which temperature it enters the tubes of *B*, cooling the air surrounding the tubes to 205 deg. The air now expands in *C* and is reduced to 160 deg., it again enters the tubes of *B* and cools the air coming from the blowing engine to 175 deg., the so-called air expands in *C* and its temperature is thereby reduced to 130 deg. and at this temperature it enters the tubes of *B*, cooling the incoming air to 145 deg. This expands and is reduced to 100 deg., and in turn cools the air in *B* to 115 deg., then to 80, to 50, to 20 deg., etc.

If the operation were continued without change, unnecessarily low temperatures would be produced. The cut-off in *C* is now



DRY BLAST.

set so as to cut off later; this reduces automatically the pressure of the air delivered by the blowing engine, to, say, 22 pounds or less, until a point is reached at which the process is so balanced that the air will leave the expansion cylinder *C* constantly at near 30 deg. The air, at a pressure of 22 pounds, is now with the same constancy cooled to 40 deg., at which pressure and temperature its moisture is precipitated. This condition is reached within 30 minutes after the beginning of operation and is maintained without change indefinitely.

At 40 deg. the cubic foot of air contains 2.85 grains of water, and since the air is at a pressure of 2.46 atmospheres absolute it would contain $2.85 \div 2.46 = 1.16$ grains per cubic foot at atmospheric pressure.

In order to reach the same result with ammonia refrigerating machines, atmospheric air must be cooled to 17 deg. Fahr. at an expense during the summer months of 2 hp per ton of furnace capacity, or 1000 hp for a plant cooling the air required for a 500-ton furnace.

The horse-power required by the method here described is calculated by Mr. Block as follows:

To compress 50,000 cubic feet of air per minute to 17 lb. gauge pressure, requires 3200 hp, and to compress the same quantity of air to 22 lb. pressure requires 3750 hp, or 550 hp more. Of this 550 hp 30 per cent may be recovered in the expansion cylinder; hence the net horse-power required for drying 50,000 cubic feet of air per minute, of whatever the moisture content of the air may be, is 370 hp, as compared with 1000 hp if ammonia refrigerating machines are used.

Electrolytic Plant for Paper Mill.

An important contract for electrical machinery has just been closed by the Oxford Paper Company, of Rumford Falls, Me., with the Western Electric Company. The machinery purchased includes five motor-generator sets consisting of five 500-hp, 2300-volt induction motors, each driving a 330-kw, 230-volt, direct-current generator, with motor-driven exciters and a 13-panel switchboard. Power is to be taken from the line of the Rumford Falls Power Company, which is increasing its plant for that purpose. Everything is of the most modern type and designed to include the latest improvements in apparatus of its class.

This electrical machinery is to be used in a large new plant which the Oxford Paper Company is now building at its Rumford Falls mills, to manufacture, for its own use, bleach liquor and caustic soda by a new electrolytic process invented by Jasper Whiting, of Boston, and developed under his direction during the past three years to a point where it is said to have obtained a high degree of efficiency. The Whiting process, which is a mercury-cathode process, was described in its essentials in our Vol. VI, p. 158. It is claimed to be exceptionally economical as regards the use of power and to require only a minimum amount of labor in its operation. The Oxford Paper Company expects a very great saving in the cost of manufacture of pulp and paper from the installation of this plant.

Triplex Buffs for Plating and Polishing Shops.

The cotton buff is one of those small things needed in every plating and polishing shop in such large quantities that it becomes quite a serious item of expense. Just for this reason many platers used to buy the cheapest buff in the market, but long ago this was found to be bad policy, since by using a better quality of buff the number of buffs needed could be

TRIPLEX BUFF.

greatly cut down, the work done by buff depending directly on the amount of long, hard-twisted fiber in the muslin used.

The "triplex buff" placed on the market by the Zucker & Levett & Loeb Co., of New York City, is a further step in the right direction. Its special feature is the fold, the prime object being to produce a cross-cutting or diagonal surface on the cutting face of the buff. The buff is made of a succession of folds so formed as to offer a greater surface to the work and at the same time to save composition. The mesh of the fabric, crossing as described, prevents the material pulling out or fraying on the working edge. The triplex buff uses up every strand of thread in the wheel.

On account of this peculiar make-up, the triplex buff is stated to have the following chief practical advantages: It does at least double the work of ordinary buffs; it saves about 20 per cent in composition; it can be used for cutting or coloring up; and finally when the wheel is worn down to, say, 7 inches the stubs may be returned to the manufacturers, and at a nominal cost they are remade into a 12-in. wheel, using two worn-down wheels to make one new wheel of approximately double the diameter.

The Cement Industry in 1908.

From a statement on the American Portland cement industry during 1908, prepared by Mr. Edwin C. Eckel for the United States Geological Survey, we quote the following:

Although detailed figures are not yet obtainable, an estimate based on the information available indicates that the production of Portland cement in the United States was somewhat less than 40,000,000 barrels. This compares as follows with the output of recent years:

1905	35,246,812	barrels.
1906	46,463,424	"
1907	48,785,390	"
1908 (estimated)	40,000,000	"

The falling off from the 1907 output was heavy, and is particularly notable because it is the first decrease shown in any year by the American cement industry since its inception. The decrease was not uniformly distributed throughout the country, for New York, Pennsylvania and New Jersey will probably show the highest percentages of loss, while in some portions of the West and the Middle West the decrease was relatively slight.

The year 1909 opens with heavy stocks of cement on hand at most mills, but with good prospects for a steady, though slow, revival in the cement trade. It is unlikely that this revival will be sufficiently rapid to push mills to their capacity during the year, and it is therefore possible that the high record for output made in 1907 will remain unbroken for another year at least. The total maximum capacity of existing plants is now about 60,000,000 barrels a year.

Draft in Steam Boiler Practice.

A preliminary bulletin on "The Significance of Drafts in Steam-Boiler Practice" is soon to be issued by the Technologic Branch of the United States Geological Survey. The authors, Walter T. Ray and Henry Kreisinger, in carrying out the particular work assigned to them in the general plan for the conservation of the fuel resources of the country, have this to say on their investigation:

The experiments so far made seem to indicate that it is possible to double or treble the capacity of a plant without making any radical changes in the furnaces and boilers. These increases require about double and treble the quantities of air to be put through the fuel beds and boilers. It also seems probable that rebaffling the boilers will often permit the capacity to be doubled or trebled, while still getting more steam than formerly per pound of coal for uses outside the boiler room.

These experiments were undertaken with the object of clarifying ideas concerning the passage of air through fuel beds and boilers. Measured weights of air were passed through two beds of lead shot, in series, one of which remained always the same and represented a boiler; the other being varied as to size of shot and depth of bed, and representing a fuel bed. Careful observations were made of the weight of air passing through the beds per minute. All data were plotted in many charts, so as to permit the study of them from several points of view. A number of laws were deduced bearing on the relative amounts of power required to force air through fuel beds of various thicknesses, composed of various sizes of coal, and through boilers of various lengths and areas of gas passages.

An important part of the discussion relates to an increase in

the capacity of boilers by increasing the amounts of power which must be applied to pressure and exhausting fans in order to force several times as much air through the fuel beds and boilers.

It may be possible, as a result of these investigations, to raise the rate of working the boiler heating surface to three or even four times its present value. Such an increase would undoubtedly mean new designs of grates, stokers, furnaces and boilers, especially fitted for high rates of working. Fan equipments designed to supply three or four times as much air under several times the pressure would be provided with more efficient engines, which is an additional factor favoring high-capacity working.

It must be borne in mind, as stated above, that the results are tentative. It will cost money to force gases at high speeds through fuel beds and boilers, and there will soon be pressing need of such quantitative data as will enable the largest possible part of the energy imparted by the fans to be advantageously utilized.

The attempt must not be made to put more air through existing boilers by running the fans a great deal faster, because the power consumed will increase far faster than the above calculations estimate. New fans and engines must usually be installed of sufficiently larger size to supply the larger quantities of air at as high an efficiency, if not higher.

As has already been suggested, one way of reducing the work required from the fan in the case of doubling the capacity of the boiler is to increase the grate surface, so as to avoid a high increase of pressure drop through the fuel bed, increasing materially only the pressure drop through the boiler proper. A low pressure drop through the fuel bed would also insure better combustion of the fine particles of coal which would be carried out of the stack unburned if high gas velocities through the fuel bed were employed, the high velocities being obtained by high pressure drops.

This last method is being successfully used by H. G. Stott and W. S. Findley, of the Interborough Rapid Transit Company, New York City. They have recently installed an extra Roney stoker under the rear end of each of several Babcock & Wilcox boilers, with the result that the amount of steam produced was nearly doubled, the combined efficiency of the boiler and furnace dropping only about 3 per cent. A complete description of the outfits and the results is given in a paper read by Walter S. Findley, Jr., before the American Institute of Electrical Engineers in December, 1907.

In this case the pressure drop through the fuel bed was the same as with the single stoker, or perhaps decreased slightly. Of course, the pressure drop through the boiler proper increased considerably. An electrical engineer would say that the above experimenters put two fuel beds in parallel and with the same potential drop obtained twice the current (weight of gases).

The same result could have been obtained by thickening somewhat the fuel bed on the single stoker and increasing the pressure drop through it, in which case the electrical engineer would say that the experimenters put two fuel beds in series and by increasing the drop of potential obtained twice the current (twice the weight of gases). The method of increasing the grate area is a promising one because it requires less work from the fans; it is especially to be preferred in those cases where there is a high percentage of slack in the coal, as already explained.

The figures and principles derived from the experiments and tests presented in this bulletin may not be applicable directly to special problems; they suggest methods by which each problem can be studied and its successful solution brought about. Further experiments with laboratory apparatus, as well as with hot fuel beds, are desirable before more accurate figures can be given. The Geological Survey contemplates the making of such experiments in the near future, the results to be worked up and published in the next bulletin on "Drafts."

Electric Annealing Furnace.

For annealing and hardening it is of great importance to have an absolutely uniform temperature in the furnace and to be able to adjust the temperature at will and exactly. The material to be tempered must be heated equally and evenly so as to prevent any possibility of strain. Overheating often burns off sharp edges and coils.

During the past few years an electric furnace of very simple construction has been developed which fulfills all these requirements. Descriptions of this furnace as built in Europe were given in our Vol. IV, page 667, Vol. V, page 428, and Vol. VI, page 410.

The furnace has now been placed on the market in this country by the General Electric Company, after having gone through a thorough development and extensive tests in their Schenectady works. From an article by Mr. J. E. Kearns, of the power and mining department of the General Electric Company, in the December issue of the *General Electric Review*, we gather the following details:

In this new furnace metallic salts are reduced to a liquid state by means of electricity. As soon as they reach a liquid condition the temperature can readily be regulated by adjusting the current through the bath, a fact which enables the operator to secure any temperature from 250 to 1350 degrees Centigrade.

FIG. 1.—ELECTRIC ANNEALING FURNACE AND REGULATING TRANSFORMER.

This temperature will remain uniform throughout the bath except at the surface, where, due to radiation, it is slightly lower. But this applies only to a depth of about 0.6 to 0.75 inch.

Fig. 1 shows the furnace outfit as it is installed in the die department of the Schenectady works, where it has been in practical service for several months.

The outfit consists of the furnace, with its hood suspended from above; the regulating transformer, with regulating switch connected to the primary coil; the switchboard, which contains the necessary ammeter and voltmeter, and the incoming line with fuses and throw-over switch connected to the secondary winding of the transformer. The regulating switch is provided with a sufficient number of contact points to insure almost any desired temperature from 250 to 1350 degrees Centigrade.

The furnaces, the general plans and section of which are shown herein, consist of a fire clay crucible surrounded by an insulating material, usually of asbestos, which rests in a fire-clay box, all being held in by an iron supporting case. Two suitable electrodes are placed on each side of the crucible and are in direct contact with the metal bath at all times.

To start up the furnace all that is necessary is to place some of the old broken flux between the electrodes and cover this with a little barium chloride, after which a small piece of

carbon is pressed tightly against one of the electrodes by the auxiliary electrode; this produces an electric arc, and in a remarkably short time the solid mass is converted into a molten condition.

After the bath has reached its proper temperature, that portion of the material which is to be hardened is placed entirely in the liquid bath and is allowed to remain there until it attains the same color as the bath, when it is removed and placed in water or oil, as required, to temper it. It can easily be seen that by this method of heating there is no chance for oxidiza-

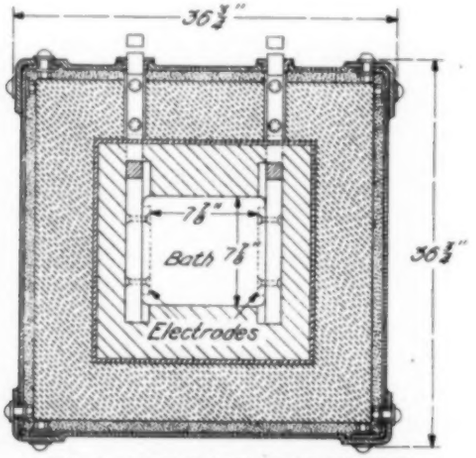


FIG. 2.—SECTIONAL PLAN OF FURNACE.

tion, for the material while heating does not come in contact with the air. Further, all parts are subject to the same amount of heat at all times. Before putting the material to be hardened in the liquid bath it is necessary to place it in a small oven above the furnace or near the bath so as to heat it slightly, because the immersing of the cold steel in the hot bath would strain it.

The bath for hardening or annealing completely fills the crucible, and usually consists of properly proportioned parts of barium chloride and potassium chloride, the correct proportion of either depending upon the material to be hardened. For ordinary good steel the Schenectady factory is using a bath of 50 per cent barium chloride and 50 per cent potassium chloride,

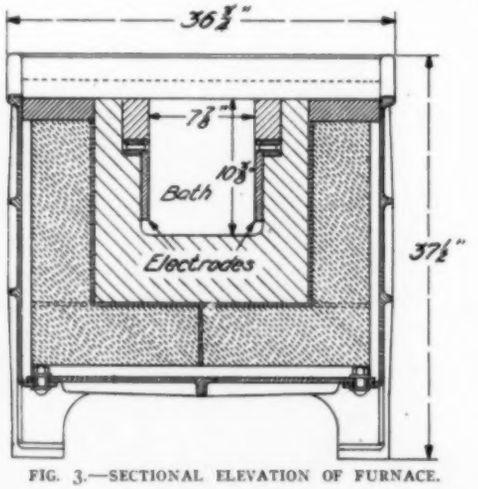


FIG. 3.—SECTIONAL ELEVATION OF FURNACE.

the amount of either being varied for raising or lowering the temperature. The more pure barium is used the higher the temperature, and the more potassium chloride is used the lower the temperature. For this class of steel a temperature of about 850 degrees Centigrade is required.

For high-speed steel where a very high temperature is required (about 1350 degrees Centigrade), the bath consists only of pure barium chloride.

For temperatures below 700 degrees Centigrade pure sodium nitrate is used, and sometimes a mixture of sodium nitrate with potassium chloride.

In addition to hardening, the furnace may be used for softening tempered steel. For this process the liquid bath is kept at a temperature of about 250 degrees Centigrade. As in hardening, this method is far superior to the oil bath, because of the careful temperature regulation obtainable, which allows the tempering colors to appear gradually.

Some comparative tests were made with this electric furnace and with a gas furnace for hardening 100 milling cutters. The total cost with the gas furnace was $19.90, with the electric furnace $6.85. The cost of gas was $10.30 (1,000 cubic feet 80 cents), against a cost of electrical energy of $4.80 (2.4 cents per kw-hour). The wages were five times greater with the gas furnace than with the electric furnace, because the operation lasts five times longer with the gas furnace.

Upon further comparison of the electric furnace with the more common lead bath or cyanide process, the former will be found very much more efficient, from the fact that the metallic salts of the electric bath have no effect on the composition of the steel, and the operator never comes in contact with dangerous fumes, such as are given off by the cyanide bath. One of the most valuable attributes of the electric furnace is the fact that there is practically no danger from fire, inasmuch as its outer walls are never hot; in fact, when the bath has a temperature of 1300 degrees Centigrade, the hand can be placed

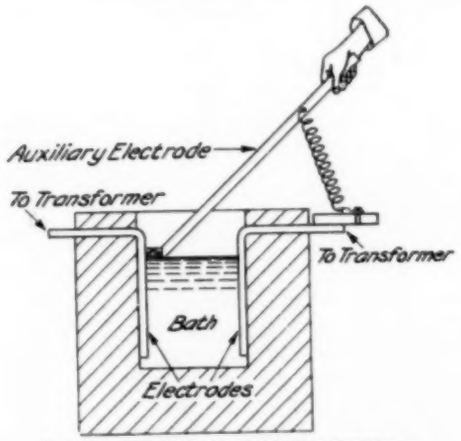


FIG. 4.—METHOD OF STARTING FURNACE.

on the outside of the furnace without being burned. A still further consideration is that the cooling bath may be placed close to the furnace, thus reducing to a minimum the time required to remove the material from the furnace and cool it.

Mr. Kearns thinks that this furnace, due to its high efficiency and its ability to anneal finished articles and leave them looking nearly as bright as when they leave the emery wheel, is bound to replace almost every other type of furnace that is called upon to meet the requirements in the tempering of dies and other steel parts used in the manufacture of the following: Machine tools, automobiles, razors, knives, firearms, files, jewelry, fine instruments, all classes of steel, chisels, twist drills, torpedo shell points, etc.

Notes.

American Electrochemical Society.—The following gentlemen were elected members at the November and December meetings of the Board of Directors: William L. Wilson, Chicago, Ill.; John W. Hulbert, Jr., Auburn, N. Y.; C. G. Seymour Bagot, Heriot Bay, British Columbia, Canada; Frank S. Washburn, Nashville, Tenn.; Dexter Edge, Wilkinsburg, Pa.; John T. Fuller, Plant City, Fla.; W. N. McAnge, Jr., Jackson, Tenn.; L. C. Tomlinson, Minneapolis, Minn.; Henri Aubry, Savoy, France; Alfred Dapples, Aguila, Italy; Frederick Von

Bidder, Holcomb Rock, Va.; Fred. W. Hersey, Loughborough, Eng.; Edward P. Hyde, Cleveland, Ohio; Leo Frank Guttman, New York City; Lewis Joseph Heizmann, Reading, Pa.; Stanley S. Seyfert, South Bethlehem, Pa.; Ezechiel Weintraub, West Lynn, Mass.; Charles L. Parsons, Durham, N. H.; Erik Cornelius, Trollhattan, Sweden; Olof Teodor Akerberg, Dalsland, Sweden; John W. Turpentine, Middletown, Conn.; Fred L. Collins, Chicago, Ill.; F. D. Crane, Montclair, N. J.; Samuel M. Kier, Pittsburgh, Pa.; A. H. Woodwell, Spokane, Wash.; Clifford D. Babcock, New York City; Robert Hunt Pierce, 839 Monadnock Building, Chicago, Ill.; Vernon G. Converse, Niagara Falls, N. Y.; Alan E. Flowers, Columbia, Mo.; Clement Alfred Smith, Santiago de Chile, S. A.; Edward C. Stover, Trenton, N. J.; Clarence W. Marsh, Niagara Falls, N. Y.; Edward Schildhauer, Culebra, Canal Zone, Panama; William Corin, Sydney, N. S. W., Australia; William Thomas Taylor, Baramulla, Kashmir, India; Ray L. Stinchfield, Washington, D. C.; Alfred Sang, Pittsburgh, Pa.; Hascal A. Hogel, Boston, Mass.; Samuel Hyam, Brooklyn, N. Y.; Rudolf Hoffman, Clausthal, Germany; Frederick J. Mayer, New York City.

Hydrogen for Balloons.—The Chemische Fabrik Griesheim-Elektron (best known by their diaphragm process for electrolysis of sodium chloride) are reported to be erecting a hydrogen plant for filling balloons. The gasometer is to have a capacity of 1,500 cubic meters, and the gas is to be obtained by water electrolysis.

The **Rockwell Furnace Company,** 26 Cortlandt Street, New York, has secured the services of Mr. Arthur L. Stevens, the well-known industrial and furnace engineer. Mr. Stevens has given much attention to the metallurgical field, especially in connection with oil and gas furnaces, and his aim will be to follow up their work in the line of economical, accurate and controllable temperature furnaces for industrial purposes, which the Rockwell Furnace Company are putting on the market.

Perkin Medal.—At the meeting of the New York section of the Society of Chemical Industry, on Jan. 22, the Perkin Medal was to be presented to Dr. Arno Behr for his contributions to the chemistry of the glucose industry. Dr. C. F. Chandler made the address of presentation and Dr. T. B. Wagner made the main speech of the evening on "The Great American Industry of Corn Products." Dr. Behr was not present. Dr. W. H. Nichols, president of the General Chemical Company, accepted the medal on Dr. Behr's behalf.

Personal.

Prof. **F. W. Harbord,** consulting metallurgist and analytical chemist of London, has entered into partnership with Mr. EDWARD RILEY, metallurgical and consulting chemist, also of London. The two businesses have been amalgamated under the style of Edward Riley & Harbord. Mr. Harbord will undertake all consulting work and continue to give his personal attention to the analytical work at his laboratory at 16 Victoria Street, Westminster. Mr. F. J. Bolt, who has been with Mr. Riley for thirty years, has joined the firm and continues to have charge of the laboratory at Finsburg Square.

Mr. **R. Livingston Fernbach** has established offices as consulting chemist and engineer at 97 to 101 Warren Street, New York City, with laboratories at Brooklyn, Boston and Montreal. The personnel of his staff consists exclusively of experts and the organization is such as to enable Mr. Fernbach to assume contracts for factory construction in its entirety. The work covered by him includes the majority of manufacturing industries which have organic chemistry for their theoretical basis, to wit.: starch, wall paper, textile industries, oils, glue, etc. In connection with his department of mines and metals it is interesting to note that those who do this work are employed by the Canadian Government, ensuring his clients of unbiased reports. Mr. Fernbach's personal work lies not so much in the laboratory as in the mills. Mr. Fernbach's staff consists of 20 members.

Digest of U. S. Patents

Compiled by Byrnes, Townsend & Brickenstein, Patent Lawyers, National Union Building, Washington, D. C.

ELECTRIC FURNACES (*Continued*).

583,249, May 25, 1897, Alfred H. Cowles, of Cleveland, Ohio.

Resistance type. The furnace is a heavy pot of carbon surrounded by a water-jacket and constituting one electrode. The other electrode is a depending carbon rod having a water-cooled holder. Horizontal water-jacketed gas pipes open into the lower end of the furnace chamber at opposite sides, and are connected through a reversing valve respectively to a source of combustible gas and air and to a discharge pipe. The passages leading through the side walls of the chamber to the gas pipes are filled with broken carbon. In operation, the furnace chamber is filled with a mixture of ore and carbon, or ore alone, which is covered at the top with a layer of fine carbon; or the top of the chamber may be sealed. The furnace is heated up to the working temperature by means of an electric current, primarily one producing a field of incandescence, and a mixture of gas and air is supplied to the lower part of the chamber through one of the pipes, burning in the interstices of the ore body. The products of combustion escape through and heat the broken carbon in the other horizontal passage. The reversing valve is then shifted, whereupon the mixture of gas and air enters through the heated body of broken carbon, acting as a regenerator, while the products of combustion escape through the carbon in the other horizontal passage, heating it. The gas flow being successively reversed, the entering mixture of gas and air is heated hotter and hotter, supplementing the electric heat both by combustion and by the recovered waste heat. Particles of soot, dust and sublimate matter picked up by the entering gas mixture are carried inward to the zone of reduction. The region of highest heat (barring an arc center) shifts laterally back and forth across the furnace chamber.

583,250, May 25, 1897, Alfred H. Cowles, of Cleveland, Ohio.

Resistance type. This furnace is similar to that of the preceding patent. The chamber may be filled with a charge of broken coke. The furnace may be used to treat gases, for example, the waste gases from electric furnaces, for the production of an illuminating or heating gas.

583,618, June 1, 1897, H. Eldridge, G. H. Wright and D. J. Clark, of Galveston, Tex.

Arc type. Vacuum furnace for the reduction of ores, fusion of metals and manufacture of alloys. The furnace is a vertical cylinder of firebrick having a hinged two-part bottom of metal covered with carbon. The sidewalls are lined with carbon. The top is closed by a metal hood, the lower edge of which enters a seal of sand. The bottom of the vertical walls is supported in a pit and surrounded by sand. The carbon lining and hearth have cathode connections. The anode is a depending adjustable tube consisting of vertical carbon bars, suspended by rods passing through stuffing boxes in the cover. A gas escape and exhaust pipe leads from the hood through the side wall of the chamber. The top has a peep-hole, closed by a mica plate. In operation, the anode is lowered until an arc springs between its lowed end and the cathode bottom. It is then slowly raised until the arc jumps between the side of the anode and the carbon lining, after which the arc travels up and down. The fused metal or substance is withdrawn through a tap hole and the slag is dumped by allowing the hinged bottom sections to drop.

583,936, June 8, 1897, Edgar F. Price, of Niagara Falls, N. Y.

Arc type. The furnace is especially designed for the production of calcium carbide, and has a chamber in the form of a trough, with an inclined hearth constituting one electrode. The hearth consists of carbon supported in a cast-iron bedplate, and is adjustable to vary its inclination. A longitudinal series of depending carbon bars serves as the other electrode. A water-cooled feed hopper surrounds three sides of the chamber, and

may consist of independent hollow iron sections, each having water pipes. The front wall has a tap hole delivering into a closed receiving chamber. The lower end of the water-cooled hopper extends downward toward the hearth, and the space between it and the side walls constitute a flue for leading the waste gases to a verticle stack. This stack has alternating inclined baffle plates for collecting and delivering solid particles which subside. Stirring arms carried by a movable chain extend downward toward the zone of reduction. The depending electrodes are electromagnetically adjusted. The connection for each carbon bar is a copper plug which is screwed into the upper end of the carbon and into a metal head to which the electric conductor is clamped.

NEW BOOKS.

Laboratory Guide of Industrial Chemistry. By Allen Rogers. 167 pages. Bound in cloth. Price, $1.50. New York: D. Van Nostrand Co.

Recent Advances in Organic Chemistry. By A. W. Stewart. (With an introduction by K. Norman Collie.) 311 pages, bound in cloth. Price, $2.50 net. New York: Longmans, Green & Co.

First Principles of Chemical Theory. By C. H. Matthewson. 130 pages, bound in cloth. Price, $1 net. New York: John Wiley & Sons.

Electrometallurgy. By J. B. C. Kershaw. Bound in cloth. Price, $2 net. New York: D. Van Nostrand Co.

Practical Sheet and Plate Metal Work. By Evan A. Atkins. 491 pages, over 100 illustrations. Bound in cloth. Price, $2 net. New York City: Macmillan Co.

Glass Manufacture. By Walter Rosenhain. 264 pages, illustrations. Bound in cloth. Price, $2 net. New York: D. Van Nostrand Co.

Manual of Reinforced Concrete and Concrete Block Construction. By C. F. Marsh and W. Dunn. 290 pages, illustrated. Price, $2.50 net. New York: Engineering News.

A Handbook for Cement Workers. By Frank B. Gatehouse. 142 pages, illustrated. Bound in cloth. Price, $1.75 net. Philadelphia: Lippincott Co.

The Gases in Rocks. By Rollin T. Chamberlin. 80 pages. paper binding. Price, 50 cents. Washington, D. C.: Carnegie Institution.

Natural Sources of Water. By Rob. S. Hall. Bound in cloth. Price, $2 net. New York: D. Van Nostrand Co.

The Elementary Theory of Direct-Current Dynamo Electric Machinery. By C. E. Ashford and E. W. E. Kempson. 120 pages, bound in cloth. Price, $1 net. New York: Putnam.

Alternating-Current Machines. (Being the second volume of Dynamo-Electric Machinery, Its Construction, Design and Operation.) By Mason Hobart, S. Sheldon and Erich Hausmann. 364 pages, illustrated. Bound in cloth. Price, $2.50 net. New York: D. Van Nostrand Co.

BOOK REVIEWS.

A Text-Book of Physics. By A. Wilmer Duff. 8vo. xi + 671 pages. Cloth. Price, $2.75 net. Philadelphia: P. Blakiston's Son & Co., 1908.

This book represents a new departure in the writing of a text-book of physics for colleges, for it is the outcome of the joint work of seven professors of physics of prominent universities and technical schools.

The book is divided into seven parts, which are as follows: Mechanics and properties of matter, 177 pages, by A. Wilmer Duff; heat, 102 pages, by Karl E. Guthe; wave motion and sound, 45 pages, by William P. Hallock; light, 45 pages, by E. Percival Lewis; electricity and magnetism, 106 pages, by Arthur W. Goodspeed; electromagnetic induction, 47 pages, by Albert P. Carman; conduction of electricity through gases and radioactivity, 35 pages, by R. K. McClung. The different parts of the work were read and revised by each of the collaborators, and finally compiled by the editor, Dr. Duff.

The practice of having several persons take part in writing a comprehensive treatise on scientific subjects is common and needs no defense. On the other hand, the production of a college text by seven men is quite a novel undertaking, and the task accomplished by the editor in getting the material into compact and coherent form was certainly not an easy one. While it is true that different chapters of a book may be written better by men who have specialized in certain fields, there is nevertheless danger in adopting this method in writing a college text that the various parts become somewhat unbalanced as compared with one another, and that the book as a whole become too voluminous. In the present case it is moreover somewhat difficult to see why three different collaborators should have been required to write what is necessary to be presented on electrical phenomena in a college text-book on physics.

The book is clearly written, though to be sure this is not true to the same degree of its several parts. All of the chapters except the fifth and seventh end with a series of problems which will no doubt be very helpful to both student and teacher. The work as a whole seems rather bulky for a college text considering the amount of time that the average college student has to spend on the subject of physics.

While it is easier to omit things from a text than to amplify it, it is doubtless best to present only the salient points (which should be most carefully selected) in such a way as to meet the needs of the student.

It will be of interest to watch the success of this book in practice. As a work of reference in connection with smaller books it will no doubt be of service; whether it will prove equally useful as a text in the classroom the future will demonstrate. The book is well printed and solidly bound in cloth.

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The Mechanical Appliances of the Chemical and Metallurgical Industries. By Oskar Nagel, Ph.D. 311 pages, 292 illustrations. Price, $2 net. New York: The Author.

"The aim of this book is to clear up ideas regarding the mechanical appliances used in the chemical and metallurgical industries, to expose the real importance of the machines used in the various processes and to get rid of the obscurities prevailing at present in these matters. It is hoped that this treatise will fill a deeply felt want, as there is only one book on the market along similar lines, viz.: Parnicke's well-known German work."

The book consists of 15 chapters dealing with the following subjects: General (covering, packing, expansion joints, valves, steam traps). Steam and water power. Gas power. Electric power. Transportation of solids (elevators, conveyors, etc.). Transportation of liquids (pumps, syphons, etc.). Transportation of gases (blowers, ventilators, etc.). Grinding. Mixing machines. Firing and furnaces. Separating. Purification of gases. Evaporating, distilling and condensing. Drying appliances. Measurement of temperature. An address by Dr. Oscar Guttmann on the works chemist as engineer is given in an appendix.

The book is chiefly descriptive and covers the chemical engineering appliances and machines now on the market in this country in a fairly complete manner. The descriptions are brief and to the point.

The merely descriptive character of the book is a point of strength, but also results in a certain weakness, as one might wish to see the underlying physico-chemical principles more thoroughly explained and discussed in various chapters.

However, the book as it is, is the only work of its kind in English and will be welcome to all who have to use chemical engineering machines and appliances. The price of the book is surprisingly low.